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EDITORIAL

GRASSES.

Animals depend for a living on the vegetable kingdom, and rely more on one family in this kingdom than on all of the three hundred other families of flowering plants combined. The family of such outstanding importance is the grasses, and there are some who contend that as the path of civilization progressed its course was directed in no unmistakable manner by the nature of the grass which grew in a particular region. The distinctive Malay and Chinese civilization was based on rice, the Aryan and Semitic civilization was based on wheat and barley, primitive African civilizations were based on the sorghums; in America there was yet another type of civilization based on maize—a grass entirely unknown in its wild stage so long has it been cultivated.

In the grasses are included the cereals—wheat, barley, rye, oats, millet and sorghum of the Old World, rice and maize of the East and of the New World. The culture of cereals dates from time immemorial. Records show that even in the twelfth century production of these crops was already intimately woven into social customs and habits; it appears, for instance, that wheat bread was associated with the luxury and entertainment of the upper classes. A Latin poem, published about that time, draws attention to a custom which found favour with the housewife of those days and which doubtless was the forerunner of some of our modern university courses in Home Economics:—

> " *With common purse they buy, 'tis said,*
> " *A single loaf of wheaten bread.*
> " *They put it under lock and key,*
> " *And if a guest they chance to see,*
> " *They bid the servant go for it—*
> " *But no one dares to cut a bit."*

Rice, it may be mentioned, is considered the world's greatest crop and forms the staple diet of more people than any other food.

In this family too, are the pasture grasses of the world. Primitive man depended largely on the animals he could kill and was, therefore, vitally associated

with grasslands for good grazing fields and food. The position has not changed greatly in the twentieth century. Elsewhere in this *Journal* is reprinted the Presidential Address to the Fourth International Grassland Congress which was held in Aberystwyth last June. A new orientation which in recent years has come more and more into prominence is that pasture grasses, being of such far reaching importance, should receive care and attention equal to that given to crops. Agricultural communities can no longer afford to permit their pastures to be untended and indiscriminately grazed. In the words with which Professor Stapledon closes his address: "If the people of the world, and to a man, are indeed to be adequately fed with fresh food of the highest quality, and balanced in every respect, then the enormous acreage of the world that stands in grassland of every character, and of no character at all, must be brought to play its full part."

In this same family are to be found the sugar cane, the oil grasses, the bamboos.

The grasses as a family are, therefore, of extraordinary importance to the world in general and in the case of many a tropical country their importance is strikingly emphasised. In British Guiana, for instance, only a relatively narrow coastal strip has been colonized and agriculturally settled; it is mainly on the output of this narrow strip that the economic life of the Colony is based. Thus far there are only two important crops that have been successfully exploited on the typical coastal soils, and both of them—cane and rice—are grasses. Latest available figures show that cane products are responsible for 68% of the Colony's exports and rice for 7%; not only are these crops of importance to the Colony's well-being but with the present outlook they are an essential for its very economic existence.

In the account with grasses, the entries are not only on the credit side. There is no winter in tropical countries to serve as a "closed season" and to interrupt the growth and spread of weeds; in consequence weed control has become one of the most important, one of the most expensive of tropical agricultural operations. The difficulties which are presented in effectively controlling weeds are responsible to a larger extent than is usually appreciated for the lack of good husbandry to which attention is so frequently drawn in the case of small-farming in the Tropics. Farmers in this country, as in many others have fallen into the habit of interchanging the word "grass" for "weeds" quite indiscriminately, for the simple reason that most of the weeds of consequence are grasses.

Although in British Guiana the fodder and pasture grasses are not playing the part which it is envisaged that they will one day play when by intelligent and orderly management a more thriving livestock industry will be supported, the Livestock Division of the Department is endeavouring to make pasture improvement one of the important features of its work. A visit to the stock farm paddock at Georgetown will show what can and ought to be done.

A direction in which the grass family is of peculiar interest to British Guiana is in regard to foreshore reclamation and conservation. In an article elsewhere in this *Journal*, the Director of Public Works and Sea Defences points out that the presence of vegetation on the foreshore of British Guiana plays an important part in reducing erosion. One of the plants found valuable in this connection is a grass, *Spartina*, which is giving useful service in foreshore conservation in this country.

In the subject matter of this Number reference to the grass family is made in more than one of the articles. For so important a subject such prominence is deserved.

ORIGINAL ARTICLES.

THE USE OF VEGETATION FOR COAST PROTECTION.

BY

GERALD O. CASE

Director of Public Works and Sea Defences.

"*When I have seen the hungry ocean gain*
"*Advantage on the kingdom of the shore*
"*And the firm soil win of the watery main*
"*Increasing store with loss and loss with store;*
"*When I have seen such interchange of state,*
"*Or state itself confounded to decay;*
"*Ruin hath taught me thus to ruminate.*"

SHAKESPEARE, SONNET LXIV.

FORMATION OF BRITISH GUIANA COASTLANDS.

The general evidence seems to prove that the present cycle of coast-line changes in British Guiana was started by an alteration in the relative levels of land and sea, which cause the formation of a very wide foreshore at low tide.

Every foreshore has a natural inclination of repose and at the commencement of the present cycle of coast-line changes in this country the gradient of the foreshore was flatter than the natural inclination. In consequence of this a natural embankment of sand and shell was built up where the waves broke at high tide. There were numbers of gaps in the naturally formed embankments through which the rivers discharged into the sea. Behind the naturally formed embankments was a large area flooded by the sea at every high tide.

The flood tidal current brought in silt and the rivers brought down sand which was deposited at slack water causing salt marshes to be gradually formed behind the natural embankments.

In the formation of these salt marshes vegetation played a very important part in organising and controlling the accretion. Plants which grow on sheltered areas covered at high tide and dry at low tide slow down currents and cause material to be deposited which in the absence of vegetation would be held in suspension and moved away. Numerous marine animals dwelt among the plants and their remains and the decay of the plants themselves caused the formation of the fertile sugar estate lands in British Guiana.

At the time of the first occupation by Europeans of this country, it is highly probable that the rate of erosion due to the gradual inland movement of sand and shell embankments was very small and perhaps negligible as they

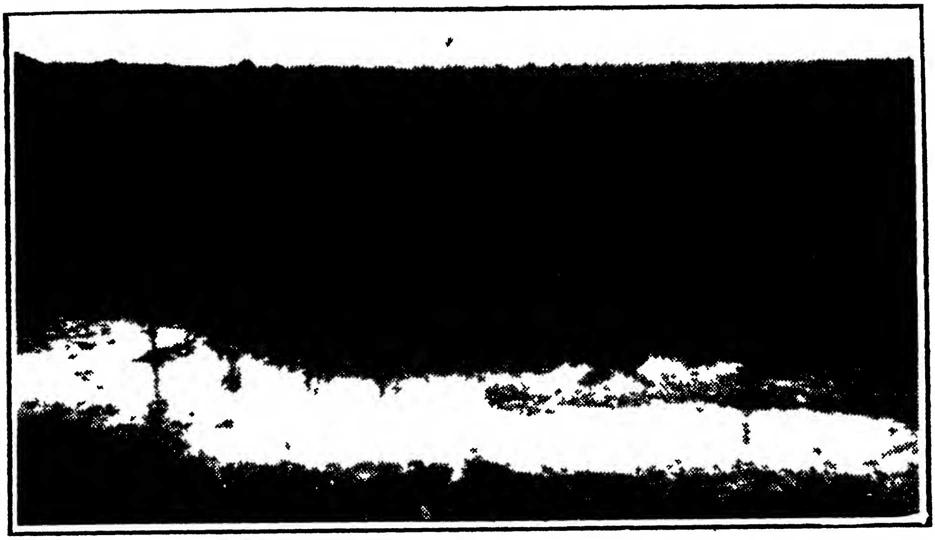

Fig. 1.—Grasses and young Courida at Nog Eens, East Coast, Demerara, taken over by sea owing to a breach in sea wall.

Fig. 2.—*Spartina* Grass growing at Kitty Foreshore, East Coast, Demerara.

PLATE II.

Fig. 3.—Various grasses and plants growing on foreshore, Hope, East Coast, Demerara.

Fig. 4.—Mangrove trees on Essequibo Coast.

were probably covered with vegetation. Reclamation of the land behind the sand and shell embankments was gradually achieved by building dams at right angles to the coast-line and putting kokers on the site of the smaller streams passing through the embankments or by cutting through the embankments and building kokers in line with them. It is highly probable that very soon after the commencement of the reclamation works sea defence troubles commenced as all naturally formed sand or shell embankments travelled inland unless fixed by vegetation. History shows that in many countries man did not at first appreciate the value of vegetation in fixing naturally formed sand embankments and preventing them gradually moving inland. In consequence the vegetation was often destroyed, and as the embankments gradually moved inland the kokers became exposed to the violent wave action as also did the artificial man-made embankments built to fill in gaps between the natural embankments. Erosion and gradual disappearance of the naturally formed sand and shell embankments was largely due to artificial causes arising from the empoldering of the marsh land and interference with natural drainage conditions.

On the parts of the coast-line of British Guiana where lands have not been empoldered, especially between the Pomeroon and Waini rivers, there still exist long lengths of sand and shell embankments clothed by vegetation and here there are no sea defence problems, but on the East and West Coasts there are only comparatively few of the natural embankments left.

On the Essequibo coast a natural sand embankment still protects low-lying land north of Suddie from inundation by the sea. Such sand embankments are found on the West Coast of Berbice and on the Corentyne Coast.

It is important to place on record the useful part which vegetation can play in preventing erosion of naturally formed sand and shell embankments so that in the future reclamation of any area behind naturally formed embankments, such as the large area between the Pomeroon and Waini rivers, care may be taken to preserve existing vegetation and plant more where necessary.

ZONES OF VEGETATION.

The vegetation of the sea-bed, foreshore and on salt marshes may be divided into zones :—

1. Sea-bed.
2. Foreshore covered by the sea at neap tides (area between high-water line of neap tides and low-water line of neap tides).
3. Foreshore covered by the sea at spring-tides only (area between high-water line of neap tides and high-water line of spring tides).
4. Salt marshes covered only by the occasional highest spring tides.
5. Sand embankments above high-water level of ordinary spring tides.

Included in these zones we find various species of both hydrophytes and hallophytes, which grow on sand and mud, and which accumulate and fix material transported by the tides and currents. The decay of these plants also adds to the rising surface. The plants are usually distributed in zones, and often very gradually pass over into salt-marsh formations. In shallow beds of seas associations of microphytes and the large algae grow on sand and mud. The hallophitic communities are divided into those that are psammaphilous, pelophilous and helophilous, according as the substratum consists respectively of sand, of mud or of swamp.

Whenever there is a breach in the line of sea defences and the sea dam is retired forming a bay to the general line of defence the salt water first kills out the land grasses and plants and then courida trees start to grow.

Fig. 1 shews young courida and salt grasses now growing in the bay caused by retiring the sea dam at Nog Eens owing to the big breach in the sea wall. The vegetation slows down the tidal current and accretion takes place at a more rapid rate than it would do in a bay without vegetation. The tendency is for erosion to take place at headlands and accretion in bays.

Beyond low-water line in Europe and parts of America, "eel" grass or sea grass (*Zostera marina*) often grows on the sea bed and rapidly accumulates sand and mud, but it is not found in British Guiana. When the shore has been raised to above low-water mark of ordinary spring tides, Spartina grass, Batis and other plants commence to grow, and when they in their turn have raised the level to above high-water mark of neap tides, other plants assist in the work of reclamation up to high-water level of ordinary spring tides.

I do not propose to give any detailed description of the foreshore vegetation in British Guiana, and would refer interested readers to the article by E. B. Martyn, published in the *Journal of Ecology*, Volume XXII, No 1, 1934, describing the foreshore vegetation eastward of the Kitty groyne.

On the coasts where the shore is of a rocky nature and high tides wash the base of the cliffs, and also where there is a comparatively small horizontal range of tide, marine vegetation and animal life produce little effect in causing accumulation. Three conditions are necessary for the formation of salt marshes on tidal foreshores. Firstly, the foreshore must be sheltered from rough seas; secondly, there must be an ample supply of sand and mud brought in by the tides or carried down by the rivers; and thirdly, there must be an adequate number of suitable plants growing on the foreshore.

The algae which grow on the sea-bed are usually attached to stones or rocks, and are not of much importance in raising the shore level. There are, however, a few species having capillary root-like organs which grow in masses on loose sand or mud. These grow on sandy shores in sheltered bays and estuaries, where there is a tendency for accumulation to take place. They assist the process of accretion in several ways. Firstly, the algal growth slows down

Fig. 5.—Courida trees being rapidly eroded by wave action at Union, West Coast, Demerara.

Fig. 6.—Holes formed in the foreshore by fallen courida trees and stumps.

PLATE IV.

Fig. 7—Young mangrove trees planted behind a bamboo pallisade to try and protect dam from erosion.

Fig. 8.—Young mangrove trees planted in front of earth dam to save expense in maintaining fascine work.

the currents and causes sand and mud to be deposited and collected; secondly, the carpet-like covering of seaweed forms a protection to the shore and tends to prevent erosion during gales; thirdly, the decay of the embedded seaweed in the gradually rising shore surface forms a humus, the sand being thus manured, and a soil is formed in course of time in which the higher forms of vegetation can grow.

On tidal muddy foreshores in many places various species of flowering plants (chiefly grasses) grow strongly from high-water to half-tide level, and form a dense mass (Figs. 2 and 3). As the surface is gradually raised by sediment deposited by the incoming tide, and in some cases by streams bringing debris worn from the land, and by accumulation of dead vegetation and shell-bearing animals, a salt marsh is formed and gradually grows seaward. The ordinary species of plants which build up salt marshes do not do so above ordinary high spring-tide level as they require to be covered periodically by the sea in order to flourish. When salt marshes have grown upwards to about ordinary high water level, the accumulation of material subsequently takes place at a very slow rate, as the conditions are then unsuitable both for salt marsh and land plants. Bushes, trees and the higher species of vegetation will not, as a rule, grow on marshes covered at occasional high tides, even by a few inches of sea-water, although there are important exceptions.

In British Guiana Spartina grasses and Batis are perhaps the most important plants on the first zone landward of low-water level. Near low-water mark black masses of sand are often inhabited by iron-sulphur bacteria, the black colour of the sand being due to the reduction of sulphates dissolved in water contained in ferruginous sand. On muddy foreshores of estuaries and bays, there are sometimes shallows which contain water even at low tide. In such places several species of tall, perennial plants grow in dense masses, and accumulation on the bottom gradually takes place.

Spartina grasses are the most valuable grasses growing on the foreshore between high water of ordinary neap and spring tides. In sheltered bays and estuaries these grasses are very effective in causing the reclamation of tidal muddy foreshores. Altogether there are about 18 known species* of Spartina, mostly natives of America. With a few exceptions they grow on salt marshes and muddy foreshores which are covered by spring tides. In places these grasses rapidly overrun large areas, hundreds or even thousands of acres of foreshore; their extensive roots fix the shore material and prevent it from being washed away. The mass of leaves to some extent breaks

*With reference to species of Spartina grass referred to, it may be noted that the Department of Agriculture carried out trials on the foreshore some years ago with *S. Townsendii*, a species which has proved of enormous value as a foreshore colonist on the coasts of England, France and Holland, and which was recommended for trial in other parts of the world. Though it grew well in the Colony when established, it was however unable to compete with the indigenous species, *S. brasiliensis*, which completely smothered it when the two came into contact. References to the two trials may be found in the Govt. Botanist's report for the years 1931-33 inclusive, and a summary of trials with these two species, made here and in other warm countries, was published in the *Kew Bulletin of Misc. Information*, 1936, p. 21.

the force of the waves, slows down the current, and causes accumulation of material on the shore which is thus gradually raised. The decay of the leaves and roots forms a humus, and therefore, while the shore level is being slowly raised, a soil is being formed which, when the level is raised high enough, will be eminently suitable for the other kinds of plants. Numerous shell-fish and animals dwell among the grasses, and their remains help to raise the shore level.

In Dr. Stapf's opinion Rice Grass mainly spreads by seed. The grains fall with the spikelets, which float, and are transported by the tides and currents to neighbouring shores, where they germinate. He suggests that the seeds may possibly lie in the water over the winter and germinate in the following spring. The seedlings soon grow into tufts, with plenty of stolens radiating in all directions, and anchor themselves to the shore by long thread-like roots which descend vertically. There is no difficulty in transplanting Spartinas.

Most grasses and plants which grow in salt water die as soon as the accumulation has been raised to high-water level; an occasional covering of salt water being necessary for their existence. Tidal forest trees, however, in sheltered places grow and accumulate detritus from below low-water to above high-water mark, thus completing the reclamation of the foreshore and sea-bed without artificial aid.

On sheltered parts of the sea-coast and in estuaries and lagoons, in or near the Tropics, certain species of trees are very effective in causing accumulation from below low-tide to about high-tide level. Unlike most vegetation, the tidal forest trees will in sheltered places grow in moderately deep water.

The tidal trees which fringe the coast line on sheltered shores in bays and estuaries form a dark-green dense belt of low trees, which, in addition to causing the reclamation of tidal foreshores, also tend to protect the coast from slight erosion. The trees raise the surface of the sea-bed and foreshore in much the same way as the lesser forms of vegetable life that is, by slowing down the currents and causing the deposit of sand and mud which is carried in suspension in the water. The roots of the trees also accumulate a lot of material which moves along the bottom by the action of currents and waves. The decay of the large number of marine animals which dwell among the foliage and leaves contributes debris to the rising surface level, and rich black soil is thus formed, which between the tide limits is evil-smelling and abounds with bacteria. Several species of crustacea burrow in the subsoil, bury dead leaves, and play a similar part to that of earthworms on land.

Warming, in his work on the Ecology of Plants, states that twenty-six species of plants grow in tidal forests. Tidal forests are often called "mangrove marshes" as the mangrove trees (species of Rhizophora) are the most important trees inhabiting tidal waters in the Tropics (Fig. 4). The trees arrange themselves zonally to a certain extent, the species of Rhizophora being generally found in the deepest water. The "air-roots" or "prop-roots" are an interesting

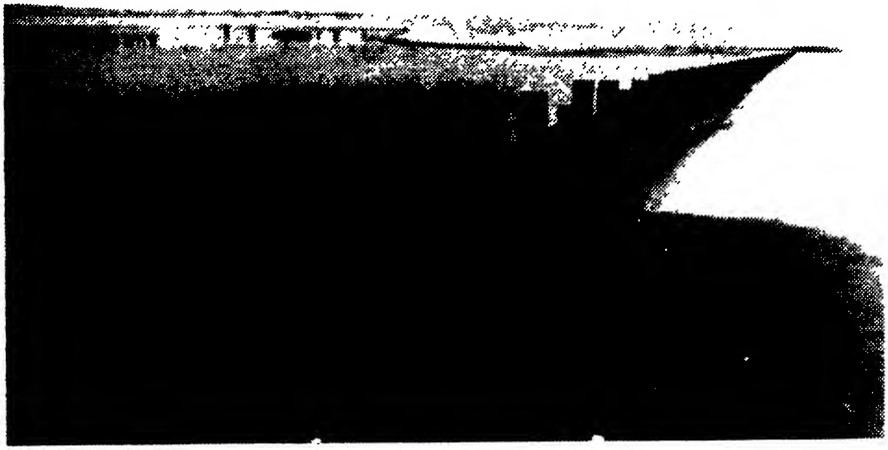

Fig. 9. Sand spit formed at Golden Fleece, Essequibo, in January, 1935. Vegetation just starting to establish itself.

Fig. 10.—Landward view from Golden Fleece groyne, Essequibo, in January, 1935.

Plate VI.

Fig. 11.—Landward view from Golden Fleece groyne, Essequibo, in September 1936. The fascined faced dam is practically hidden.

Fig. 12.—Natural sand and shell embankment at Woodlands, East Coast, Demerara.

feature of many of the tidal trees. There are either erect or kneed branches of the roots which project above the shore surface. They are provided with minute openings (stomata or lenticles) which allow air to pass in and be carried by means of passages in the soft spongy tissue to the roots embedded under the shore. The "prop-roots" also serve as supports to the trees and securely fix them to the sea-bed. The power of resisting bending caused by wind or sea is much greater in the case of trees having aerial roots than those having a main stem only.

The tidal forests multiply by seeding and also by means of runners. In several species of Rhizophora the embryo plant grows into a more or less developed plant while still attached to the parent tree. Long radicles emerge from the seed and descend rapidly towards the shore surface where the latter may establish itself before falling off the parent tree. If the seedlings break loose and fall into the water or mud, their club-shaped pointed roots enable them to fix themselves into the mud; or if the water is too deep, the seedlings are transplanted by the current, and may strike root on another part of the coast. Some of the seeds of the tidal forest trees are provided with devices which enable them to float.

On the East Coast, Demerara, courida trees grow freely above mean sea level and in the estuaries of the large rivers mangrove is usually very plentiful.

Courida is useful in building up and consolidating a muddy shore subject only to overflow at high spring tides, but, on the other hand, it is useless to prevent violent erosion by wave action. If severe erosion starts the courida stumps are very harmful, and increase the rate of erosion. In the past it has been necessary to spend large sums of money in removing courida stumps from the East Coast foreshore (Figs. 5 and 6).

From a health point of view the coast-line of a belt of courida is, in populated areas, very objectionable. When an exposed foreshore, subject to wave action, has built up to about high tide level, the courida has practically completed its work in causing accretion and there is no objection to its removal provided all the stumps are taken away and the foreshore planted with spartina or other suitable grasses which will cover it. In estuaries, where the shore is sheltered from violent wave action, mangrove trees are a very effective protection against erosion and should not be cut down.

On parts of the Islands of Wakenaam and Leguan the mass of mangrove roots effectively protects the coast from erosion by current action. In many cases erosion has been started by cutting down the mangrove at the koker outlets to provide a landing place for boats. Efforts are now being made to re-establish the growth of mangrove in abandoned boat landing places by forming a pallisade of sticks or bamboo and planting young mangrove trees behind. The pallisade is at first necessary to protect the young plants (Figs. 7 and 8).

In connection with this matter it is important to differentiate between the effect of a mass of tree stumps or roots on a shore subject mainly to current and a shore subject to heavy wave action. On the protected shore subject chiefly to current action tree stumps and roots are effective in slowing down the current and preventing erosion. On shores which suddenly become subject to violent wave action the tree stumps and roots cause erosion and aid the destructive forces of the waves. Holes are formed round each root stump lowering the foreshore and causing the uneven surface to be more easily attacked by waves.

Sand embankments and sand spits enclosing bays are sometimes formed where there is a predominant littoral drift in one direction. When the sand bar has been raised to mean tide level vegetation actively assists in raising the shore level landward of the spit or embankment. Figs. 9, 10 and 11 illustrate a sand spit formed at Golden Fleece, Essequibo Coast, in 1935 and the action of vegetation in building up the shore.

SAND AND SHELL EMBANKMENTS.

In the actual formation of sand embankments above high water level vegetation plays a very important part. On foreshores where there is sand it is dried by wind and sun at low tide, and as soon as it becomes dry the wind is able to transport it inland. As a general rule, the prevalent winds are onshore, and such winds are more effective in moving sand inland than the less frequent seaward winds in moving sand back again.

Sand embankments on the coast-line above high water level are generally formed by the accumulation of sand against some obstruction. Trees, shrubs, grasses, fences &c., may occasion the lodgement of sand in considerable quantities.

On the seacoast, the formation of embankments is chiefly due to vegetable life. The various kinds of grasses which grow in sand just landward of high water are very effective sand collectors. Each plant or group of plants forms in effect an openwork fence and collects sand in the manner previously described. Many of the various grasses which thrive on sandy coasts grow upward as the sand accumulates; thus in time dunes of considerable size are formed.

Where there is insufficient vegetation to fix sand embankments properly as they are brought into existence on the coast margin, they are rapidly moved inland. In Europe large areas of fertile land and even villages have been completely overwhelmed by the advancing sand; and sand deserts as a consequence formed. The inland movement of unfixed sand embankments has often resulted in the inland movement of high-water line, thus causing serious erosion of the coast as well as the devastation of the land. In places where the sand blown inland from the foreshore is not replaced by sand brought in by sea action or littoral drift, the erosion of the foreshore naturally takes place.

Fig. 13. Natural sand embankment at Suddie, Essequibo, overgrown with *Ipomoea biloba*

The velocity of the inland travel of a sand embankment is the rate of advance of the crest, which takes place by the accumulation of sand on the steep lee slope. The supply is brought in two ways: firstly, by the rolling of coarse sand grains over the crest; and secondly, by the deposit of part of the the vegetation flying sand caught by the eddy and not tossed away again.

If covered with vegetation sand dunes form a consolidated barrier against the encroachment of the sea. The roots of the various grasses and plants bind the surface, and the foliage catches and retains sand abstracted from the foreshore by wind action (Figs. 12 and 13). The dune thus grows in height and width, the vegetation in many cases accommodating itself to a rising surface level.

On the Gascony coast of France, coast sand dunes were formerly moved inland by wind action, causing erosion of the coast and devastation of the land by the formation of a miniature Sahara. All this, however, has been changed by the work undertaken by the French Government, and instead of vast areas of bare desolate sand, there are now productive pine forests. The success of this work was largely due to the initiative of a French engineer, M Brémontier, who, over a hundred years ago, devised a system for fixing and reclaiming the Gascony sand dunes.

Documentary evidence shews that at the time of the first Roman reclamation of Holland the sand embankments were clothed with trees on their landward slopes and in places even partially down the seaward slope. Old geographers describe forests on the dunes extending to very near the sea. There is little doubt that not realising the value of the trees for fixing the dunes and preventing their inland movement, the trees were cut down with the result that in the Middle Ages chroniclers refer to the drifting sand embankments.

The growth of grasses and small shrubs on the sea face of the dunes down to high water level of spring tides, is essential to bind the sand and collect fresh inblown sand.

In the past the vegetation was often damaged by pedestrians and cattle. Now very stringent laws are enforced in Holland to ensure the careful preservation of vegetation and the coast is constantly patrolled.

The efficiency of vegetation in consolidating sand dunes and preventing coast erosion has for many years been widely recognised, and numerous laws have been passed to prevent its destruction.

In the reign of Queen Elizabeth an Act was passed to prohibit the destruction and to encourage the cultivation of vegetation on sand embankments.

In early times there were laws in force in numerous manors in England to prevent injury to coast sand embankments. The Records of the Manor of Ingoldmells in the County of Lincoln, shew that in the reign of Edward II, five Orders of Attachment were made against various persons for "doing damage in pasturing on the sea banks, for mowing the dunes and herbage outside the bank of the sea, against the defence of the sea for the salvation of the country, at the Manor Ingoldmells"

STATUS OF THE AMAZON FLY IN BRITISH GUIANA, 1937.

BY

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INTRODUCTION.

It is necessary to follow for a number of years the status of an introduced parasite in its new environment before an opinion can be formed as to the *rôle* the insect is playing in combating the pest for which it was secured.

Examinations made on sugar estates at different times after the introduction of the Amazon Fly into this country showed long since that the insect had established itself not only in sugar-cane but also in rice, and as regards the former crop at least was parasitizing a fair proportion of the *Diatraea saccharalis* in that host plant.

A survey carried out about the middle of 1935 by Mr. F. A. Squire, while engaged as Supernumerary Entomologist in this Department, showed further that some two years after the introduction of the parasite and the colonization of the sugar estates the insect was still doing good work. The results of this survey were not published.

About a year ago it was considered desirable to undertake another survey, and in January 1937, the work was commenced, continuing, as opportunity allowed, to January 1938. In the present survey it was not possible to carry out examinations of all the sugar estates in the Colony owing to the pressure of other work and the limited staff of assistants, but a total of fifteen sugar estates was examined during the survey extending from Pln. Skeldon on the extreme east of the Colony to Plns. Versailles and Schoon Ord on the West Bank of the Demerara River. It is believed, however, that both the number of estates examined as well as the area over which they are extended are sufficient to allow the results to be considered as being representative of the general conditions over the sugar-growing area.

As regards Pln. Albion, Berbice, the survey of that estate was carried out in conjunction with Mr. H. W. B. Moore, Entomologist of the estate, who undertook the field collections of material.

COLONIZATION OF THE SUGAR ESTATES, 1933-35.

Before dealing with the present position of the fly, some information as to the introduction of the insect and the subsequent colonization of the estates will be given.

The first consignment of the Amazon Fly arrived in British Guiana from Brazil on 30th August, 1933, and between that date and 31st October, 1933, a total of six consignments was received totalling 3,000 puparia, and from these 1,409 flies were secured. From these initial stocks some liberations were made directly into the sugar-cane fields, as well as material obtained to start extensive rearing operations.

Rearing of the fly was commenced at Headquarters Laboratory on the Sugar Experiment Station as early as 21st September, 1933. Later as the work progressed laboratory assistants were trained in the technique of rearing the insect and field laboratories set up in conjunction with the different estate authorities on ten sugar estates scattered over the sugar area of the coastlands.

These estate laboratories served to stock the plantations on which they were situated, and which in most instances were at too far distances from Headquarters to be stocked from there. Such estate laboratories were situated in the county of Berbice and on the East Bank, West Bank and West Coast, Demerara. All the estates on the East Coast, Demerara, besides a few on the East and West Bank Demerara and in Berbice, were colonized solely with flies reared at the Headquarters Laboratory.

During the period these laboratories were in operation a total of over 379,000 flies was reared in all laboratories, of which over 18,000 were produced at Headquarters Laboratory. As regards Headquarters Laboratory, work ceased in April 1935, and no flies were supplied to the estates which were colonized from this laboratory after that date. Many of the estate laboratories continued rearing for a few months longer, however, but by September or October 1935 practically all had ceased work in this direction. There were a few exceptions to this where the rearing of flies continued for some time longer, namely, Plns. Port Mourant and Leonora to November 1935, Pln. Albion to December 1935 and Pln. Blairmont to June 1936.

Table I gives the number of flies distributed to the estates from Headquarters Laboratory, between September 1933 and April 1935, and Table II shows the number of flies reared in all laboratories, between September 1933 and November 1935.

For about three years, therefore, as far as the East Coast Demerara estates are concerned, and from about the end of 1935 in most other instances, the fly has been continuing on its own, under conditions that it must meet and survive if it is to exert any control on *Diatraea* in the Colony. Just how well it has accomplished this the present survey will show, in part at least.

Method of Survey.

In explaining the method used in obtaining data in the present survey some account of the habits of the moth-borer and of the fly will help. In the early stages of the attacks of moth-borer on sugar-cane the larvæ bore into the

TABLE I.—Amazor Flies distributed from Headquarters Laboratory to Sugar Estates for Colonisation or as Breeding Stock, 1933-35.

	1933				1934												1935				TOTALS
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Sugar Expt. Station				358	305	69	119		365	367							54			305	1,942
Pln. Ogle													75								75
„ Vryheid's Lust																		77			77
„ La Bonne Intention													414	294	354				71		1,133
„ Lusignan	28	216	371	120	565	107	193	91			472			120	86			171	86		2,626
„ Non Pareil			388	357		309						67							131		1,252
„ Enmore			253	353		191		162													959
„ Cane Grove									564	501	782	261					233	124			2,465
„ Houston																307					307
„ Providence					143	516	930	119							*23	*3					1,734
„ Farm															*27						27
„ Diamond									*327	*41											368
„ Versailles								202	352		212										766
„ Schoon Ord							299	387	69							61	156				972
„ Wales											*39		*8								47
„ Leonora																	*34				34
„ Uitvlugt																*21	*8				29
„ Blairmont									696												696
„ Albion				246	*90	*201		*110													647
„ Port Mourant									*567												567
„ Skeldon																					
„ Rose Hall																	183	426	450		1,059
„ Lochaber																			175		175
„* Friends																			217		217
TOTALS	28	216	1,012	1,434	1,103	1,393	1,541	1,071	2,940	909	1,505	328	497	414	490	392	668	798	1,130	305	18,174
	2,690				12,583												2,901				

* Principally Breeding Stock.

	NO. OF FLIES REARED.											TOTALS
	H Q.	Blair-mont	Albion	Port Mourant	Skeldon	Providence	Farm	Diamond	Wales	Leonora	Uitvlugt	
1933												
October	53											53
November	1,310											1,310
December	2 021											2,021
Total	3,384											3,384
1934												
January	1,445											1,445
February	2,357											2,357
March	2,295											2,295
April	2,260											2,260
May	2,521	849	448									3,818
June	1,421	2,604		252				1 124				5,401
July	1,796	4,169	694	3,386				2 273				12,318
August	696	2,981	1,836	2,191	466			3,324	487			11,981
September	803	2,807	2,762	4,361	331			1,714	300			13,078
October	810	2,417	2,609	3,512	1,240			1,995	415			12,998
November	639	1,938	2,043	2,360	1,469	7	170	3,834	731			13,191
December	945	3,298	3 228	4,049	4,208	1,866	1 447	4,336	519		37	23,933
Total	17,988	21,063	13,620	20,111	7,714	1,873	1,617	18,600	2,452		37	105,075
1935												
January	978	7 220	3,232	4,183	2,742	1,850	1 524	4,157	1,392	10	467	27,755
February	1,229	7,320	2,335	3,064	2,167	2,161	1,589	4,106	1,829	748	1,219	27,767
March	1,647	13,663	2 123	3,224	2,127	1,930	1,213	1,652	1,540	1,086	1,491	31,696
Total	3,854	28,203	7,690	10,471	7,036	5,941	4,326	9,915	4,761	1,844	3,177	87,218
April	113	12,760	2 867	3,688	1,382	2,210	1,794	2,794	1,391	1,362	1 842	32,203
May		16,300	2,704	4,227	1,520	2 292	2,038	2,876	1,299	1,914	2,337	37,507
June		13,186	2,820	3,367	1,510	2,085	1,792	1,228	1,486	1,625	2,549	31,648
July		9,049	1,820	3,060	1,884	2,357	1 699	1,217	1,396	1,756		24,238
August		6,744	1 579	2,275	1,359	2,357	1,976	1,963	1,091	1,938	5,033	26,315
September		2,233	1,276	3,040	263	1,985	301	1,212	759	1,817	1,556	14,442
October *		2,031	730	2,302					524	1,870		7,457
November		1,367	1,215	685						1,617		4,884
December		2,947	2,379									5,326
Total	3,967	94,820	25,080	33,115	14,954	19 227	13,926	21,205	12,707	15,743	16,494	271,238
Grand Total	25,339	115,883	38,700	53,226	22,668	21,100	15,543	39,805	15,159	15,743	16,531	379,697

young stalks and destroy the central leaf, producing what is generally termed a "deadheart." When the stalk has reached the stage of jointing, however, it is not normally killed, the moth-borer larvæ boring into such stalks and tunnelling them to a greater or less extent.

The Amazon Fly in attacking the moth-borer larvæ deposits eggs or larvæ at the entrance of the moth-borer tunnels or in their vicinity. The larvæ so deposited, directed either by smell or reacting to some other stimulus, enter the borer tunnels and eventually find their way to the *Diatraea* larvæ. Having entered the *Diatraea* larvæ the parasites continue to develop, and by the time they are ready to pupate the host larva has succumbed so that the parasite is able to leave the then mere remains of the moth-borer larva. The parasite then pupates, either about the entrance of the moth-borer tunnel, or sometimes outside behind a leafsheaf, or even, occasionally, at the base of the plant on the ground.

To obtain an estimate of the work of the parasite in the field it is necessary to ascertain the number of the host parasitized, including such of the parasites as are found in the pupal stage at the time of the examination.

For this purpose field examinations were made, and data compiled therefrom. In these examinations fields of between six weeks and two months old were used, as it was considered that this would be representative of fields which would be normally worked were "borer gangs" being employed in hand collecting, and would contain a fairly representative *Diatraea* population in their young stages.

In each such field the collection of *Diatraea* was undertaken on a fixed method, which consisted of making collections in the field at 10 places spaced about equally across the field diagonally. At each of these places the "deadhearts" in two rows were cut and examined. In each field it was the endeavour to obtain at least 100 *Diatraea* larvæ in the collection, but if the *Diatraea* population was low (as often occurred) this was not always possible and under such circumstances the examination of the field continued, cutting "deadhearts" from rows in the same areas, for a period of 3 boy-hours.

The *Diatraea* larvæ were collected from these "deadhearts"—both *D. saccharalis* and *D. canella* were secured, as were also the living *Diatraea* pupae and Amazon Fly puparia; the result was noted on a form, and the material brought back to the labatory for examination.

Diatraea larvæ obtained in the field examinations were subsequently dissected in the laboratory and the actual parasitism noted, while the Amazon Fly puparia collected were kept for emergence of flies and hyperparasites.

On each estate at least twelve fields were examined (Pln. Farm excepted where only seven fields were examined) for preference on consecutive days, but in two instances such examinations comprised a larger number of fields and/or

were taken at two different periods. There was no selection of fields beyond the limitation of age, which has already been mentioned, and an attempt to have the number of fields examined distributed as nearly as possible equally among the stands, namely, plants, first, second and third ratoons. Usually the fields on the estates which complied with the conditions as regards age were listed by the estate authorities at the beginning of the examination of each estate, and from such lists twelve were selected at random so as to be distributed over the cultivation.

RESULTS OF THE SURVEY.

Fifteen estates in all were taken in the survey and on these a total of 212 fields were examined, comprising 88 plant fields, 54 first ratoons, 56 second ratoons and 14 third ratoons. Of the total of 212 fields, in 155 fields (73.1 per cent.) the Amazon Fly was found parasitizing either *D. saccharalis* or *D. canella* or both, 144 fields showing a parasitism of *D. saccharalis* only, but no field was found in which only *D. canella* was parasitized.

In these fields a total of 37,332 "deadhearts" were cut out, of which 20,998 or 56.3 per cent. were empty. Of the remainder, 14,274 (37.9 per cent. of the total) contained living *Diatraea*, in the proportion of 6,271 or 43.9 per cent. *D. saccharalis* (the black-headed borer) and 8,003 or 56.1 per cent. *D. canella* (the yellow-headed borer). 2,060 or 5.5 per cent. of the "deadhearts" were the result of "Other Causes" including white grubs (hard back beetles) and rats.

Table III gives the details of these figures as regards each estate.

In 5,371 *D. saccharalis* found in Positive Fields, 863 or 16.0 per cent. were found to be parasitized by the Amazon Fly at the time of examinations of the fields ("Current Parasitism of Positive Fields") the parasitism ranging from 3.4 per cent. to 36.2 per cent. While of the total of 212 fields, 39 or 18.4 per cent. showed parasitisms of *D. saccharalis* of 30 per cent. and over. If, however, all the fields examined are included, both positive and negative ("Current Parasitism in All Fields") the parasitism works out at 13.7 per cent. *D. saccharalis*. see Table III.

The parasitism for *D. canella*, as expected, was low, 0.32 per cent. for "Positive Fields" and 0.23 per cent. for "All Fields."

As regards the individual estates little need be said. It will be seen that the results of the surveys of Pln. Port Mourant and Pln. Blairmont have been given in two sections each, and some explanation in this respect may be of value.

On the occasion of the first survey at Pln. Port Mourant the parasitism was particularly low, and much lower than examinations on previous occasions had revealed. As that examination was made during a dry period it was thought that the low parasitism might be attributed to weather conditions.

TABLE III.—AMAZON FLY SURVEY, 1937-38—RESULTS OF EXAMINATIONS OF SUGAR ESTATES.

Estate.		Date of Examination	FIELDS EXAMINED.							STALKS EXAMINED				DIATRAEA				AMAZON FLY—CURRENT PARASITISM			
			Total	Plants	1st Rats.	2nd Rats.	3rd Rats.	Positive	Negative	Total	Empty	Diatraea Living	Dead-hearts O.C.	In Positive Fields		In All Fields		In Positive Fields		In All Fields (±)	
														Sac.	Can.	Sac.	Can.	Sac.	Can.	Sac.	Can.
Skeldon	No.	19/25 January	19	4	9	4	2	15	4	4313	2112	1791	410	592	1037	604	1187	67	3	67	3
	%										49.0	41.5	9.5	36 3	63.4	33.7	66.3	11.3	0 3	11.1	0.3
Port Mourant I	No.	2/9 January	22	2	8	12	—	13	9	5212	3089	2062	61	388	1057	548	1514	28	1	28	1
	%										59 3	39 6	1 1	26.8	73.1	26 6	73 4	7 2	0.09	5.1	0.06
II	No.	27/30 July	12	7	3	2	—	10	2	2307	1536	749	22	341	280	347	402	108	0	108	0
	%										66 6	32.4	1.0	54.9	45.1	46.3	53.7	31.6	0.0	31.1	0.0
Albion	No.	January 1938	12	4	4	4	—	12	0	3897*	2568	1307	22	927	380	927	380	101	0	101	0
	%										66.0	33.4	0.6	71.0	29 0	71.0	29.0	10.9	0 0	10.9	0.0
Rose Hall	No.	2/5 March	15	5	3	6	1	13	2	2033	769	1263	1	357	682	366	897	61	1	61	1
	%										37.8	62.1	0.1	34.4	65.6	29.0	71.0	17.4	0.15	16.7	0.11
Blairmont I	No.	10/16 June	4	2	1	—	1	4	—	643	466	132	45	96	36	96	36	28	0	28	0
	%										72.5	20.5	7.0	72 6	27.2	72.6	27 3	29.3	0.0	29.3	0.0
II	No.	11/14 January 1938	12	6	4	—	2	5	7	2078	1004	1058	16	597	19	1013	45	20	0	20	0
	%										48.2	50.8	0.7	96.8	3.1	95.7	4.3	3.4	0.0	2.0	—
Cane Grove	No.	25 Feb./31 Mar.	12	6	—	6	—	9	3	1886	1216	590	80	116	327	134	456	24	4	24	4
	%										64.5	31.3	4.2	26.2	73.8	22.7	77.3	20.7	1.2	17.9	0.87
Enmore	No.	19/21 April	12	4	6	2	—	5	7	1811	1044	655	112	227	199	291	364	28	0	28	0
	%										57.6	36.2	6 2	53.2	46.7	44.4	55.6	12.3	0.0	9.7	0.0

Non Pareil	No.	29 April/5 May	12	3	7	1	1	9	3	2291	1235	714	342	242	320	293	421	34	3	34	3
	%										53.9	31.2	14.9	43.0	57.0	41.0	59.0	14.0	0.94	11.6	0.71
Lusignan	No.	10/14 May	12	6	—	3	3	6	6	1778	790	620	368	112	192	143	477	25	0	25	0
	%										44.4	34.9	20.7	36.8	63.0	23.1	76.9	22.3	0.0	17.5	0.0
L.B.I.	No.	26/28 May	13	4	3	6	—	9	4	1592	504	683	405	212	375	266	417	38	0	38	0
	%										31.7	42.9	25.4	36.1	63.7	38.9	61.1	17.9	0.0	14.3	0.0
Ogle	No.	31 June/5 July	12	9	1	2	—	12	—	1429	932	485	12	211	274	211	274	68	5	68	5
	%										65.2	33.9	0.9	43.5	56.5	43.5	56.5	32.1	1.8	32.1	1.8
Diamond	No.	9/12 August	12	5	—	3	4	11	1	1753	958	795	—	253	512	259	536	56	0	56	0
	%										54.6	45.4	—	33.0	67.0	32.6	67.4	22.1	0.0	21.6	0.0
Farm	No.	August	7	7	—	—	—	6	1	840	411	396	33	201	162	203	193	64	1	64	1
	%										48.9	47.1	4.0	55.3	44.6	51.3	48.7	31.6	0.6	31.4	0.5
Versailles	No.	14/16 July	12	8	1	3	—	9	3	1550	1211	308	31	188	99	191	117	68	0	68	0
	%										78.1	19.9	2.0	65.5	34.5	62.0	38.0	36.2	0.0	35.6	0.0
Schoon Ord	No	7/10 Decr.	12	6	4	2	—	7	5	1919	1153	666	100	317	121	379	287	45	0	45	0
	%										60.1	34.7	5.2	72.5	27.5	57.0	43.0	14.2	0.0	11.9	0.0
TOTAL			212	88	54	56	14	155	57	37332	20998	14274	2060	5371	5692	6271	8003	863	18	863	18
PER CENT.				41.5	25.4	26.4	6.6	73.1	26.9		56.3	37.9	5.5	49.6	51.4	43.9	56.1	16.0	0.32	13.7	0.23

' Estimated.

Accordingly it was arranged that at a later date when wetter conditions occurred, another examination of the estate would be undertaken. The second examination, made under similar conditions in all respects except as regards weather conditions, gave a much higher parasitism, and it is believed that this higher figure was due primarily to this cause.

The position at Pln. Blairmont was somewhat different. On that estate the first examination, which was made under wet conditions, showed a high parasitism, but owing to the pressure of other work, had to be discontinued after only four fields were examined. In January 1938, Mr. G.M. Eccles, Manager of Blairmont Estate, reported a severe attack of *Diatraea* in certain fields and opportunity was taken to examine these fields to ascertain the position with regard to the parasite, and at the same time other fields on the estate were examined to complete total of twelve fields and the survey of the estate.

As to the conditions connected with this outbreak, it would appear that to some extent at least the attack was associated with a heavy growth of the grass *Echinochloa crusgalli cruspavoris* (HBK) Hitch. which occurred after the fields were taken in from water-fallow and in which *Diatraea saccharalis* was present. In addition, the four fields attacked are situated at the most distant part of the estate, and unlike other fields, have no immediately adjacent fields; there would be little possiblity, therefore, of flies spreading into these fields from outside, and the population introduced in the normal way with the tops may not have been sufficient to deal with the position, or found conditions unfavourable.

NUMBER OF PARASITES PER HOST.

Records were kept during the survey as to the number of parasites per host. Of a total of 863 *Diatraea saccharalis* records, it was found that 513 or 59.1 per cent. contained only a single parasite, 263 (30.5 per cent.) contained two parasites, 66 (7.6 per cent.) contained three parasites, 17 (1.9 per cent.) four parasites and only 4 (0.5 per cent.) contained five parasites per host.

The puparia of the fly found in the field agreed very closely with these figures and were in the proportions of 59.4, 31.4, 7.5, 1.4 and 0.3 per cent. for one, two, three, four, and five parasites per host respectively.

HYPERPARASITISM.

In January 1937, Mr. H. W. B. Moore recorded a hyperparasite of the Amazon Fly from Pln. Albion, Berbice.

This appearance of a hyperparasite was not unexpected for it had long been known that the native fly parasite of *Diatraea*, *Leskiopalpus* (*Stomatodexia*) *diadema* Wied. was attacked by the hyperparasite *Signiphora dipterophaga* Girault,

and the possibility of this insect attacking *Metagonistylum* was well recognised at the time of the introduction of the Amazon Fly. This was confirmed when a determination of the insect was made by Dr. C. Ferrière of the Imperial Institute of Entomology.

In addition, Squire, in his report of 1935, had mentioned the finding of a puparium of *Metagonistylum* which apparently had been attacked by a hyperparasite although he did not obtain any specimens of the insect.

Accordingly during the survey precautions were taken to secure hyperparasites in order to obtain data as to the prevalence of the insect.

On four estates of the fifteen the hyperparasite was obtained, namely, Plns. Port Mourant, Albion, Diamond and Farm. This would indicate that the hyperparasite is well distributed over the sugar area.

Of the 45 fields examined on these estates in 13, or 29 per cent., hyperparasites were found, while of 178 puparia collected, 17, or 9.6 per cent. produced hyperparasites. If, however, the whole Amazon Fly population of these fields is considered, namely 516 larvæ and puparia, the percentage destroyed by hyperparasites would only be 3.3 per cent.

Table IV gives the details as regards examinations of the estates in relation to the hyperparasitism.

Table IV.—Amazon Fly Survey, 1937-38. Hyperparasitism of Amazon Fly Puparia by *Signiphora dipterophaga*.

Estate.	No. of Fields.		Puparia.		Amazon Fly Population Larvæ and Pupæ.	Hyperparasitism Per cent.		
	Examined	Hypers found.	Total.	With Hypers.		Fields.	Puparia.	Amazon Fly Population.
Port Mourant	12		60	5	163	25.0	8.4	3.1
Albion	12		38	3	148	20.0	7.9	2.0
Diamond	12		37	5	90	33.3	13.5	5.6
Farm	7		43	4	115	43.0	9.3	3.5
Totals	43	13	178	17	516	27.1	9.6	3.3

Other Parasites.

Other larval parasites, *Braconids*, were met with during the survey and note was taken of these also. In the *saccharalis* population in all fields numbering, as we have seen, 6,271, *Braconid* parasites to a total of 59 or 0.94 per cent. were obtained, while for a *canella* population of 8,003, 24 *Braconid* parasites or 0.3 per cent. were present.

With regard to the native fly parasite *Leskiopalpus*, unfortunately no data are available. While it is definitely known from observations and examinations undertaken during the period covered by the survey that *Leskiopalpus* does occur in both the East Coast and East Bank districts, none of the insects was obtained in the examinations which actually constituted the survey. Accordingly no figures are given for the present prevalence of the insect.

CONCLUSIONS.

From the results given above we may draw some conclusions as to the present status of the Amazon Fly in the Colony.

As the result of this survey it has been found that not only is the Amazon Fly present in the fields but that it occurred in 73 per cent. of the fields examined. That in such fields the fly was parasitizing an average of 16.0 per cent. of the *D. saccharalis* population and 0.32 per cent. of the *D. canella* population, and taken over all fields these figures were 13.7 per cent. and 0.23 per cent. respectively. The parasitism ranged from 3 4 per cent. to 36.2 per cent. for "Positive Fields" and 2 0 per cent. to 35.6 per cent. in "All Fields." In 18.4 per cent. of "Positive Fields" the parasitism of *D. saccharalis* was 30 per cent. and over.

Commenting on the larval parasitism, Myers (1) in his very thorough review of the *Diatraea* situation in 1931, stated that the combined parasitism of the eight important parasites was 6 9 per cent. of the borers in cane. The larval parasitism by the Amazon Fly of 16.0 per cent. *D. saccharalis* in the present survey must, therefore, be considered as very satisfactory.

As regards the other larval parasites, the *Braconids* were present only to the extent of 0.9 per cent. in *D. saccharalis* and 0 3 per cent. in *D. canella.*

Unfortunately no data are available for the native fly parasite *Leskiopalpus* in connection with the present survey. It must be made clear that the fact that no parasitism by this insect was obtained in the survey samples does not indicate the disappearance of this insect. On the contrary, during the period covered by the survey, as stated previously, the fly was observed in the field, but its absence in the survey samples does indicate its comparative scarcity at the time.

That the prevalence of this insect is affected by weather conditions there can be little doubt, but it should be pointed out in addition that the only authoritative statement we have on its prevalence is that of Myers (1) that, "The *Paratheresia* and *Stomatodexia* are together responsible for a mortality of 3.2 per cent. borers in cane, but they apparently do not extend activities to the small grasses."

It has been stated that *Leskiopalpus* (*Stomatodexia*) does not occur in Berbice. The fly is no doubt of rare occurrence there but the writer reared this insect from *Diatraea* at Pln. Blairmont, Berbice, in February 1922, and since then the insect has been on other occasions taken in the same locality. From localities east of the Berbice river there appears to be no records of its occurrence.

On four of the fifteen estates examined hyperparasites were found. Hyperparasitism of Amazon Fly puparia occurred in 27.1 per cent. of the fields on the estates on which it was found; and 9.6 per cent. of the puparia were attacked.

In this connection it should be pointed out that the hyperparasitism, occurring as it does to puparia, takes place after the parasite has done its work and killed the host larva. The destruction of the host population to the extent of 16.0 per cent. (in this survey) has already taken place. Further, if the hyperparasitism is calculated on the whole Amazon Fly population it is only 3.3 per cent.

The survey has shown also, to some extent at least, that there is a variation of the prevalence of the fly due to weather conditions, and so serves to confirm previous observations of this nature.

There also appears to be a somewhat uneven distribution of the fly on estates, and occasionally there have been severe attacks of *Diatraea* in fields. This is to be expected for some time after the introduction of a new species, and until it settles down in its new environment. That, since its introduction, there have been so few outbreaks of *Diatraea* speaks well for the fly. The fact should not be lost sight of that the large majority of the sugar estates in the Colony (there are two or three exceptions) have only on rare occasions employed a "borer gang" since the colonization of the estates with the Amazon Fly was completed in 1935.

Thompson (3) tells us that even when conditions are relatively favourable to the parasite the course of events may not always present a very satisfactory appearance and says:

"Perhaps the most important point to remember in this connection is "that during the period which follows the introduction and establishment "of a species, and the time when it has reached the highest population which "it can attain in the area, there is an intermediate period during which "the species increases slowly but steadily in numbers, but during which "this increase may be masked by local irregularities of various kinds, so "that in one locality the parasite may appear for a certain length of time to "increase with extreme rapidity, while in another it exerts absolutely no "effect, after which it may disappear from the first locality and become "abundant in the second."

In the survey as undertaken it must be borne in mind that the data obtained represent conditions as found at a particular time and stage in the growth of the crop. It is, therefore, not to be considered as necessarily the best that the insect is capable of performing or even the best that it is doing at the present time. In fact the contrary is the case for we have found fields in the present survey in which as high as 80 per cent. of the *Diatraea saccharalis* population has been parasitized, while

18.4 per cent, of the positive fields showed parasitism of 30 per cent, and over, and even the *canella* parasitism is often higher than has been found in the examinations now reported upon. Had the examinations been made at a later stage in the growth of the crop there is more than a probability that the parasitism by the Amazon Fly would have been considerably higher. For that reason alone it would seem desirable to undertake at a later date more detailed examinations of a few estates extending over the whole period of the growth of the crop.

That the Amazon Fly is doing good work in the sugar area the figures given now leave no room for doubt. There can likewise be no doubt as to the value of the introduction, nor that the cost of the undertaking has been amply repaid.

Beyond this we should not go at present, remembering Thompson's advice that "The entomologist should be as much on his guard against premature reports of success as against premature complaints of failure." It is still too early to draw conclusions or make statements as to the future work and destiny of the parasite, and mere guesses, pious opinions, or statements based on scanty data, are of no value.

REFERENCES.

(1) MYERS, J. G. (1931). A Preliminary Report on an Investigation into the Biological Control of West Indian Insect Pests. E.M.B. 42. H.M. Stationery Office, London, July 1931.

(2) SQUIRE, F. A. (1935). Colonial Development Fund. Progress Report on the Present Status of the Amazon Fly in British Guiana. (Unpublished Report).

(3) THOMPSON, W. R. (1930). The Biological Control of Insect and Plant Pests. E.M B. 29. H.M. Stationery Office, London, June 1930.

PLANT LEGISLATION IN BRITISH GUIANA AND THE CARIBBEAN COLONIES.

BY

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Within recent years, as the result of research in entomology and plant pathology, there has come about a better understanding of the pests and diseases affecting plants and the manner in which they are spread. With the acquisition of this knowledge there has followed the development of measures for their control and prevention, and to-day there are few countries in the world where efforts are not made to combat such pests and diseases of plants as occur within their borders and to prevent the introduction of others from outside.

In order to do this effectively, it has been found necessary to enact legislation, and plant protection legislation is now almost universal. In the British Empire alone such legislation is extensive, and it will be seen from the summary which follows that even in the comparatively small area which is dealt with here it is not inconsiderable.

The countries of tropical America, including British Guiana and the British Colonies of the Caribbean, have had their full share of devastating pests and diseases in the past. It is not surprising, therefore, that these countries have enacted legislation, the aim of which is to prevent the introduction of pests and diseases from areas outside their borders and to control them where they occur within.

In the summary given here, an effort has been made to bring together in a concise form the existing legislation as it affects this Colony. For convenience, the information has been grouped into two parts, namely: (1) that existing in British Guiana both as regards internal matters as well as import and export prohibitions and (2) that referring to the British Colonies in the Caribbean.

With this summary it should be possible for individuals concerned either with the import or the export of plants and plant products, including fruit and vegetables, to ascertain easily what restrictions are in force with respect to any particular, or to all, products in the area. It should be borne in mind, however, that while the summary is complete at the present time, alterations and additions are made from time to time, so that in future it will be necessary always to obtain information as to any amendments which may have taken place since the compilation of the present summary.

BRITISH GUIANA.

SUMMARY OF LEGISLATION AFFECTING AGRICULTURAL INDUSTRIES.

1. PLANT QUARANTINE.

I. External—Import Prohibitions.

A. PROHIBITED ARTICLES, INCLUDING PLANTS, SOIL AND PACKAGES AND ARTICLES CONNECTED THEREWITH.

Articles prohibited.	Country of origin.	Reasons for prohibition.	Index of Legislation.
Sugar canes and any plants or parts thereof	All countries	Prevention of introduction of disease	Order-in-Council under Ordinance No. 37 of 1935
Plants of grasses of any kind	"	"	"
Earth or soil or any thing packed therewith	"	"	"
Pimento and Bay tree (*Pimenta acris*)	Jamaica	Rust disease	Notice in *Official Gazette* dated December 3, 1936
Citrus material (including fruit)	United States of America	Citrus canker (*Phytomonas citri*)	Order-in-Council under Ordinance No. 37 of 1935
Fruit (except plantains, nuts and dried, canned, candied and other preserved fruits) Vegetables (except onions, Irish potatoes and canned or preserved vegetables)	All countries except British Isles, Canada and the British West Indies not including Bermuda and the Bahamas	Mediterranean Fruit Fly (*Ceratitis capitata*)	Order-in-Council under Section 28 of Customs Ordinance Cap. 33 dated May 19, 1930, as amended by Order-in-Council dated Aug. 20, 1934
Raw coffee	All countries on the continent of South America	Coffee berry-borer (*Stephanoderes hampei* Ferr.)	Regulations made under Ordinance No. 37 of 1935

B. PROHIBITED ARTICLES, EXCEPT UNDER LICENCE.

Articles prohibited.	Country of origin.	Reasons for prohibition.	Index of Legislation.
Sugar canes and any plants or parts thereof (imported by the Director of Agriculture for scientific purposes)	All countries	Prevention of introduction of disease	Order-in-Council under Ordinance No. 37 of 1935
Banana and plantain suckers	"	"	"
Raw Coffee	All countries other than South America	Coffee berry-borer (*Stephanoderes hampei* Ferr.)	Order-in-Council under Ordinance No. 37 of 1935
Bees and Beekeepers' stock	All countries	Prevention of introduction of disease	Regulations made under Ordinance No. 38 of 1935

C. PERMITTED ARTICLES, PROVIDED THESE HAVE PASSED INSPECTION BY THE AGRICULTURAL DEPARTMENT.

Articles permitted.	Country of origin.	Index of Legislation.
Garden seeds	All countries	Order-in-Council under Ordinance No. 37 of 1935
Plants, seeds, cuttings, bulbs or other plant parts intended for propagation	"	"

II. Internal—Control of Disease and Pests Within the Colony.

Diseases and Pests.	Locality.	Index of Legislation.
Brassolis sophorae L. (Coconut Caterpillar)	Generally	Notice in the *Official Gazette* under Plant Diseases and Pests Regulations 1936 making these notifiable diseases and pests.
Marasmius perniciosus Stahel. Witchbroom Disease of (Cacao).	North West District	

2. MISCELLANEOUS LEGISLATION AFFECTING AGRICULTURAL INDUSTRIES.

Measure.	Object	Index of Legislation.
Wild Birds Protection	Close season; prohibition of export, killing and sale	Cap. 273 as amended by Ordinance No. 27 of 1934
Government Lands Orchids and Haiari	Prohibition of export of	Regulation 70 of Crown Lands Regulations 1919
Botanic Gardens	Control of	Government Botanic Gardens Regulations 1936
Agricultural Shows, etc.	Control of public gardens and grounds and Government Agricultural Stations and holding of shows	Ordinance No. 34 of 1935

PLANTS AND PLANT PRODUCTS, &c., EXCLUDED FROM BRITISH GUIANA.

Prohibited Importations	Country of origin.
Sugar canes and any plants or parts thereof	All countries
Plants of grasses of any kind	
Earth or soil	
Pimento and Bay tree	Jamaica
Citrus material including fruit	U.S.A.
Raw Coffee	All countries prohibited except under licence. South America absolutely prohibited
Banana and Plantain suckers	All countries
Plants, bulbs, seeds and other propagating material	
Bees and beekeepers' stock	
Garden seeds	
Fruit	All countries except British Isles, Canada and the British West Indies (not including Bermuda and the Bahamas)

CARIBBEAN COLONIES.

SUMMARY OF LEGISLATION IN FORCE RELATING TO THE IMPORTATION OF PLANTS.

Country.	Article.	Instrument.	Date.	Provisions.
	BANANAS.			
Antigua	Fruit of	Proclamation under Plants Protection Ordinance 1923	4th March. 1936	Prohibited from all countries except other islands of the Leeward Islands and the U.S.A.
	Plants and parts thereof	,, ,,	,,	Prohibited from the Bahamas, Bermuda, British Guiana, Central America, Dutch Guiana and any island or place in the West Indies and the other islands of the Leeward Islands Colony (except under licence granted by the Governor).
Barbados	Stools or bits (*Musa* spp.)	Plant Pest & Disease (Importation) Act. 1932	—	Prohibited from all countries except as imported by the Director of Agriculture for scientific purposes.
Bermuda	Plants and parts thereof (except fruit)	Bye-laws made by the Board of Agriculture under provisions of The Boards Act. 1920	28th April, 1936	Prohibited from all countries.
	Fruit of	,, ,,	,,	Prohibited from all countries unless imported without wrapping, cover or packing of any kind.
British Honduras	Plants and parts thereof and any other species of the genus *Musa*	Proclamation under Statutory Rules & Orders No. 18 of 1934	4th May, 1934	Prohibited from the West Indian Islands, Guatemala, Honduras, Nicaragua, Costa Rica, Panama, South America, Canary Islands and West Africa (except imported by the Department of Agriculture for experimental purposes or under licence issued by the Agricultural Officer.)
Dominica	Fruit of	Proclamation under Plant Protection Ordinance 1927	5th August, 1932	Prohibited from all countries except Barbados and the Islands of the Leeward Islands Colony.
Jamaica	Plants or parts thereof or articles used as packing or covering for	Proclamation under Customs (Importation Prohibition) Law of 1916	3rd April, 1917	Prohibited from all countries.

Montserrat	Plants or parts thereof including their fruit	Proclamation under Plants Protection Ordinance 1897	13th July, 1934	Prohibited from all places except Barbados and the Leeward Islands except upon licence from the Governor or in small quantities by the Curator of the Botanic Station for scientific purposes.
St. Kitts—Nevis	Fruits	Proclamation under Plants Protection Ordinance 1923	2nd July, 1937	Fruits—Prohibited from all places except U.S.A. and the Leeward Islands.
	Plants and parts of banana plants			Plants, etc.—Prohibited from all countries except under licence by the Governor.
St. Lucia	Plants or parts thereof	Proclamation under Plants Protection Ordinance 1909, etc.	—	Prohibited from Jamaica, Grenada, Trinidad, Tobago, South and Central America, Canary Islands and West Africa.
St. Vincent	Banana, plantain or other *Musa* spp.	Proclamation under Plants Protection Ordinance No. 14 of 1935	—	Prohibited from all countries except by Agricultural Authority through or with the approval of the Plant Quarantine Station, Trinidad.
Trinidad and Tobago	Plants, seeds, cuttings or other parts of	Proclamation No. 32 of 1930 under Plant Protection Ordinance No. 29 of 1919	—	Prohibited from all countries except under permit from the Director of Agriculture, Trinidad.
	CITRUS.			
Antigua	Lime plants and parts of lime plants	Proclamation under Plants Protection Ordinance 1923	4th March, 1936	Prohibited from British Guiana, Dominica, Grenada, Montserrat, St. Kitts, St. Lucia and Trinidad, unless under licence granted by the Governor.
	Fruit of the lime	,, ,,	,,	Prohibited from the Bahamas, Bermuda, British Guiana, Dominica, Grenada, Montserrat, St. Kitts, St. Lucia, Trinidad and all other countries of the British West Indies and the U.S.A. unless under licence granted by the Governor.
Barbados	Lime and citrus stocks	Plant Pest & Disease (Importation) Act, 1932	22nd Oct., 1932	Prohibited from all countries except as imported by the Director of Agriculture for scientific purposes.
British Honduras	Citrus plants including plants of grapefruit, orange, lemon, lime and tangerine	Statutory Rules & Orders No. 6 of 1934 (Proclamation)	13th Feby., 1934	Prohibited from all countries except that orders may be placed through Agricultural Department and plants subjected to various restrictions etc. until it is ascertained that they are free from disease.

CARIBBEAN COLONIES.

SUMMARY OF LEGISLATION IN FORCE RELATING TO THE IMPORTATION OF PLANTS.—(*Contd*).

Country.	Article.	Instrument.	Date.	Provisions.
	CITRUS (contd.)			
Dominica	Fruit of the lime	Proclamation under Plants Protection Ordinance No. 2 of 1927.	5th August. 1932	Absolutely prohibited from the Bahamas, Bermuda British Guiana, St. Lucia, Trinidad and all other countries except the other islands of the British West Indies not herein mentioned.
	Rooted plants and parts of the citrus family	" "	"	Prohibited from all countries unless under licence granted by the Governor and accompanied by a health certificate in respect of citrus canker.
Jamaica	Fruits or any parts thereof, fresh and dried, but not including candied fruit or preparations in the form of jam or marmalade	Proclamation under Law 23 of 1916	19th June. 1934	Prohibited from all countries.
	Plants, buds and grafts	Orders under Law 10 of 1926	18th June. 1925 5th Dec. 1933	Prohibited from all countries but may be imported by the Director of Agriculture at any time from any country.
Monsterrat	Rooted plants or parts of the citrus family including their fruits, except the fruit of orange or grapefruit	Proclamation under Plants Protection Ordinance No. 3 of 1897	13th July. 1934	Prohibited from all countries except under licence granted by the Governor or except in small quantities by the Curator of the Botanic Station for experimental or scientific purposes.
St. Lucia	Citrus plants (Citratæ) or any parts thereof	Proclamation under Plants Protection Ordinance 1909	—	Prohibited from all countries unless under licence by the Governor-in-Council and under the provisions of such licence.
St. Vincent	Citrus (except fruit of orange and grapefruit from the British West Indies)	Proclamation under Plants Protection Ordinance 1935	--	Prohibited from all countries except by Agricultural Authority through or with the approval of the Plant Quarantine Station, Trinidad.
Trinidad and Tobago	Plants seeds, cuttings, fruit or other parts	Proclamation No. 32 of 1930 made under Plants Protection Ordinance No. 29 of 1919	—	Prohibited from all countries except under permit from the Director of Agriculture, Trinidad.

	COCONUTS			
Barbados	Seed coconuts for propagation	Plant Pest and Disease (Importation) Act, 1932	22nd Oct., 1932	Prohibited from all countries save under permit from the Director.
British Honduras	Any part or portion of the coconut palm (*Cocos nucifera* L.) including plants, leaves, leaflets and unhusked fruits	Proclamation under Statutory Rules and Orders No. 25 of 1933	14th Aug., 1933	Prohibited from all countries except by the Department of Agriculture for experimental work.
Dominica	Sprouted coconuts and coconuts in husk	Proclamation under Plants Protection Ordinance No. 2 of 1927	5th Aug., 1932	Prohibited from all countries unless imported under licence granted by the Governor.
Jamaica	Coconuts in husk and copra	Proclamation under Customs (Importation Prohibition) Law No. 23 of 1916	15th May, 1923 2nd Sep., 1933	Prohibited from all countries.
Montserrat	Growing or sprouted coconuts	Proclamation under Plants Protection Ordinance No. 3 of 1897	13th July, 1934	Prohibited from Trinidad, St. Vincent, Grenada, Cuba, Jamaica, and all parts of Central and South America except upon licence granted by the Governor or in small quantities by the Curator of the Botanic Station for experimental or scientific purposes.
St. Lucia	Coconuts, coconut plants and any parts thereof	Proclamation under Plants Protection Ordinance 1909	—	Prohibited from all countries unless under licence by the Governor-in-Council and under provisions of such licence.
St. Vincent	Coconut	Proclamation under Plants Protection Ordinance No. 14 of 1935	—	Prohibited from all countries except by the Agricultural Authority through or with the approval of the Plant Quarantine Station, Trinidad.
Trinidad and Tobago	Coconut	Proclamation under Plants Protection Ordinance No. 29 of 1919	—	Prohibited from all countries except under permit from the Director of Agriculture, Trinidad.
	SUGAR CANE AND OTHER GRAMINEAE			
Antigua	Sugar cane, sugar cane seedlings and plants and all parts of the sugar cane	Proclamation under Plants Protection Ordinance 1923	—	Prohibited from all countries except under licence granted by the Governor.

CARIBBEAN COLONIES.

SUMMARY OF LEGISLATION IN FORCE RELATING TO THE IMPORTATION OF PLANTS.—(*Contd*).

Country.	Article.	Instrument	Date.	Provisions
	SUGAR CANE AND OTHER GRAMINEAE —(Contd.)			
Barbados	Sugar cane cuttings, stems, leaves and other parts, except the seed of any plant of the order Gramineae	Plant Pest and Disease (Importation) Act, 1932	—	Prohibited from all countries except as imported by the Directer of Agriculture for scientific purposes.
Bermuda	Sugar cane, maize, broom corn and other sorghums	Bye-laws made by the Board of Agriculture under provisions of The Boards Act, 1920	28th April, 1936	Prohibited from all countries.
British Honduras	Sugar cane (*Saccharum officinarum* L.) sugar cane seedlings and plants and all other parts of the sugar cane, and earth or soil or any articles packed therewith	Proclamation under Statutory Rules and Orders No. 39 of 1935	30th August, 1935	Prohibited from all countries except under licence issued by the Governor.
Dominica	(a) Sugar cane, sugar cane seedlings and plants and all parts of the sugar cane	Proclamation under Plants Protection Ordinance No. 2 of 1927	5th August, 1932	(a) Prohibited from all countries unless under licence granted by the Governor.
	(b) Johnson Grass (*Holcus halepensis*)	,, ,,	,,	(b) Prohibited from the Bahamas, Bermuda, British Guiana, and all other countries except the British Isles, Canada, British West Indies and the U.S.A.
Montserrat	Sugar cane plants	Proclamation under Plants Protection Ordinance No. 3 of 1897	13th July, 1934	Prohibited from all places except under licence granted by the Governor or by the Curator of the Botanic Station for experimental or scientific purposes.
St. Kitts—Nevis	Sugar cane, sugar cane seedlings and plants and all parts of the sugar cane	Proclamation under Plants Protection Ordinance No. 2 of 1923	2nd July, 1937	Prohibited from all countries except under licence by the Governor.

St Lucia	Sugar cane plants, fodder, grasses or any parts thereof and any member of the Gramineae	Proclamation under Plants Protection Ordinance 1909	—	Prohibited from all countries save under licence by the Governor-in-Council and under the provisions of such licence.
St. Vincent	Sugar cane, plants seeds, cuttings, or other parts thereof	Proclamation made under Plant Protection Ordinance No. 14 of 1935	—	Prohibited from all countries except by the Agricultural Authority through or with the approval of the Plant Quarantine Station, Trinidad.
Trinidad and Tobago	Sugar cane, plants seeds, cuttings, or other parts thereof	Proclamation No. 32 of 1930 under Plants Protection Ordinance No. 29 of 1919	—	Prohibited from all countries except under permit from the Director of Agriculture, Trinidad.
	OTHER CROPS.			
Barbados	*Mango stocks	Plant Pest and Disease (Importation) Act, 1932	22nd Oct., 1932	*Prohibited from all countries except as imported by the Director of Agriculture for scientific purposes.
	†Tubers, bulbs, cuttings, rooted plants and aerial plants			†An import permit issued by the Director of Agriculture is required.
Bermuda	Sweet Potatoes	Bye-laws made by the Board of Agriculture under provisions of The Boards Act, 1920	28th April, 1936	Prohibited from all countries.
	Bulbs and Plants of *Lilium*	" "	"	" "
	Plant material (including cut flowers) arriving by air-service	" "	"	Prohibited from all countries unless imported under licence previously obtained from the Director of Agriculture or the Plant Pathologist.
British Honduras	All fresh fruit and vegetables	Proclamation under S.R. & O. 1932	21st July, 1932	Prohibited from all countries except Canada, U.K. and Ireland, U.S.A. and Jamaica.
	Tobacco seeds	Proclamation under S.R & O. 21/33	1st August, 1933	Prohibited except under licence issued by Agricultural Officer
Dominica	Fresh fruits and vegetables (except plantains)	Proclamation under Plant Protection Ordinance 1927	5th August, 1932	Prohibited from all countries except the British Isles, Canada, B.W.I. and U.S.A.
Jamaica	" "	Proclamation under Customs (Importation Prohibition) Law of 1916	13th Jany., 1934	Prohibited from all countries except U.K. and Ireland, Canada, Bahamas, U.S.A. and New Zealand

CARIBBEAN COLONIES.

SUMMARY OF LEGISLATION IN FORCE RELATING TO THE IMPORTATION OF PLANTS.—(*Contd*).

Country.	Article.	Instrument.	Date.	Provisions.
	OTHER CROPS (contd.)			
St. Kitts—Nevis	Fresh fruits and vegetables (except plantains)	Proclamation under Plants Protection Ordinance 1923	2nd July, 1937	Prohibited from the Bahamas, Bermuda, British Guiana, Venezuela and all other countries and places except the British Isles, Canada, B.W.I. and U.S.A.
St. Lucia	,, ,,	Proclamation under Plants Protection Ordinance 1909	—	Prohibited from all countries except the British Isles, Canada and B.W.I.
	Cocoa plants or parts thereof	,, ,,	—	Prohibited from South America, East and South of the Isthmus of Panama.
St. Vincent	All plants, seeds, fruits, cuttings or other parts of cocoa, sweet potatoes, cassava, arrowroot, hevea, nutmegs, groundnuts, coffee* (including raw coffee, husked or unhusked)	Proclamation under Plants Protection Ordinance No. 14 of 1935	—	Prohibited from all countries except by the Agricultural Authority through or with the approval of the Plant Quarantine Station, Trinidad. *Raw coffee from British Guiana may be imported into St. Vincent if accompanied by a certificate of origin from the Department of Agriculture, British Guiana, and shipment must be made by steamers which do not carry raw coffee from countries infested by coffee berry-borer and whose terminal port is Georgeown.
Trinidad and Tobago	Cocoa plants or portions thereof and cocoa beans	Proclamation No. 32 of 1930 made under Plant Protection Ordinance No. 29 of 1919	—	Prohibited from any part of the mainland of South America.
	Cured cocoa beans	,, ,,	—	Prohibited from any part of the mainland of South America except Venezuela and Colombia.
	All fresh fruits and vegetables except plantains	,, ,,	—	Prohibited from all countries except the British Isles, Canada, United States of America and the B.W.I.
	Pineapples, yams, sweet potatoes, tannias, eddoes and dasheens	Proclamation No. 21 of 1932	—	Prohibited from all countries except the British Isles, U.S.A., British Guiana and Canada.

	EARTH, SOIL, Etc			
Antigua	Soil and plants growing in soil	Proclamation under Plants Protection Ordinance 1923	4th March, 1936	Prohibited from the Bahamas, Bermuda, British Guiana, Trinidad and all other countries except the British Isles, Canada, the other islands of the B.W.I. and the U.S.A.
Barbados	Soil, covering, wrapping or other material in which a plant has been grown	Plant Pest & Disease (Importation) Act, 1932	—	Prohibited from all countries except under an import permit issued by the Director of Agriculture.
Bermuda	Soil or plants growing in soil	Bye-laws made by the Board of Agriculture under The Boards Act, 1920	28th April, 1936	Prohibited from all countries, unless imported under licence previously obtained from the Director of Agriculture or the Plant Pathologist.
British Honduras	Soil or earth or plants packed or growing therein (except citrus plants)	Proclamation under S.R. & O. 19/32	21st July, 1932	Prohibited from all countries, except provided with a certificate of introduction as granted by the Agricultural Officer after inspection and if necessary fumigation.
Dominica	Soil	Proclamation under Plants Protection Ordinance 1927	5th August, 1932	Prohibited from all countries.
Jamaica	Earth or soil	Proclamation under Law 23 of 1916	19th June, 1934	Prohibited from all countries.
St. Lucia	Earth or soil, goods, packages or containers which have contained (a) banana plants or any parts thereof (b) plants and seeds of any kind (c) cocoa plants or parts thereof	Proclamation under Plants Protection Ordinance 1909	—	Prohibited from all countries.
St. Kitts—Nevis	Soil	Proclamation under Plants Protection Ordinance 1923	2nd July, 1937	Prohibited from the Bahamas, Bermuda, British Guiana, Trinidad and all other countries and places except the British Isles, Canada, the U.S.A. and other Islands of the B.W.I. not specified in this item.
St. Vincent	Soil and packages containing soil	Proclamation under Plants Protection Ordinance 1935	—	Prohibited from all countries except by the Agricultural Authority through or with the approval of the Plant Quarantine Station, Trinidad.
Trinidad and Tobago	Soil and packages containing soil	Proclamation No. 32 of 1930 under Plants Protection Ordinance 1919	—	Prohibited from all countries.

PLANTS AND PLANT PRODUCTS EXCLUDED FROM THE CARIBBEAN COLONIES.

SUGAR CANE AND OTHER GRAMINEAE.	BANANAS.		CITRUS.	COCONUTS (Sprouted or in husk)	OTHER CROPS.
	Bananas only.	Bananas and Plantains			
Antigua	Antigua	Barbados	Antigua	Antigua	Barbados (mango stocks, etc.)
British Honduras	Dominica	British Honduras	Barbados	Barbados	Bermuda (sweet potatoes, etc.)
Dominica	Jamaica	St. Vincent	British Honduras	British Honduras	British Honduras (fresh fruit and vegetables, tobacco seeds)
Montserrat	Montserrat		Jamaica	Jamaica (copra also)	Dominica (fresh fruit and vegetables)
St. Kitts-Nevis	St. Kitts-Nevis		Dominica	Montserrat	Jamaica (fresh fruit and vegetables)
St. Lucia	St. Lucia		Montserrat	St. Lucia	St. Lucia (fresh fruit and vegetables. cocoa)
St. Vincent	Trinidad		St. Lucia	St. Vincent	St. Vincent (coffee—except under licence. cocoa, cassava and ground-nuts, sweet potatoes, arrowroot. nutmegs, hevea)
Trinidad			St. Vincent	Trinidad	Trinidad (fresh fruit and vegetables, coffee and cocoa)
			Trinidad		

SELECTED ARTICLES.

PRESIDENTIAL ADDRESS.*

(Fourth International Grassland Congress).

BY

PROFESSOR R. G. STAPLEDON.

Greenness is the subject of my address, for grass is greener and more variedly and more vitally green than anything in the whole wide world, and green is the vital colour. Young succulent grass is the prince of feeds. Over an enormous area of the world grass is the foundation of the agricultural industry, and perhaps almost everywhere it should be the foundation. Research may well make this possible—yes, possible everywhere.

Grass (and when I say "grass" I mean, of course, grass and clover) properly used ensures soil fertility, grass marries the soil to the animal and the solid foundation of agriculture is the marriage of animal and soil. That spells humus. While again grass properly employed counters the devastating influences of erosion.

I am proud indeed to welcome you here to grassy Wales. Though Wales, I hasten to add, is not proud of her grasslands. Indeed, for my own part, and speaking as one who has spent twenty-five years conducting research on grassland in Wales, I must admit I find the condition of the grasslands of this country as a whole, and not only of Wales, deeply humbling. But then Great Britain, you see, and to the untold benefit of some of you here present, has always liked to finance agriculture anywhere, everywhere, except within her own shores.

*The 4th International Grassland Congress was held in Great Britain last year, and was attended by representatives from 37 different countries.

Although the majority of the world's great grassland areas lie outside the tropics, yet grassland plays an important part in the agriculture of every country, and at the Congress the discussions and demonstrations brought out points of general application that every cattle owner, wheresoever he be, can take to heart.

Some of the most striking demonstrations shown to those attending the conference included the changes and betterment in pastureland that can be secured by proper rotational grazing, the possibilities of turning to good pasture, by tillage and manurial treatment, land which had formerly been regarded as waste and almost valueless, and the remarkable improved strains of common pasture grass that can be obtained by selection and breeding.

Professor Stapledon's Presidential Address to the Congress deals with some of the general problems facing the owner of grassland, and indicates how they are being faced elsewhere. The owner of grassland should look on it as akin to arable land, to bear a crop of the proper grasses and these alone, to be manured and subject to rotational treatment, to be properly drained and irrigated and to be suitably fenced. As is pointed out in the address, a small area of pastureland carefully tended can be many times more valuable than a vastly greater area of uncared-for 'grassland' on which cattle run at will.

E. B. M.

I have travelled more than a little, and I know something of grasslands in general, but I have not travelled or seen as much as I should have liked, and I can express no well-informed opinions on many types of the world's grasslands.

I have, however, come to this opinion, and I believe it to be just, nay more, fundamental, that the only rational approach to the problems of grassland (the practical problems and the research problems), is the wide regional approach.

The first necessity is to classify our grasslands, and to understand their interrelations, and then to work and to plan on the basis of clearly defined regions—natural regions. The proper use of grass and of grassland is a matter of systems of farming, and therefore of facilities. It is a matter essentially of the right implements, the right fertilisers, and pre-eminently of the right seeds. More than this, it is a matter of usage and custom; systems of land tenure; methods of marketing and a hundred other things, all of which can only be appreciated properly and tackled successfully on a regional basis. What is generally essential is to discredit old fashions and to introduce new fashions. In this country all manner of old-fashioned clauses in leases are, for example, a great handicap to the introduction of new and long overdue methods. In the matter of seeds, the essential thing is to use the right strain of the comparatively few species that really suit the needs of any well-defined natural region. To organise this is by no means an affair only of plant breeding. The plant breeding to be of maximum benefit should, however, be conducted in the region it is proposed to serve. It is only by chance, for example, if anything we breed here at Aberystwyth suits say Natal, North America or Norway, and if it does appear to do so at the first flush some plant disease—a rust form, say—may quite decisively intervene. Exploration yes, and the bringing of new species and of new genes of tried species into every region, but the selection and plant breeding must be conducted within the regions. What we want is not a world-wide interchange of commercial seeds with their limited variability, but a world-wide interchange of genes. It is probably nearer the truth to say that there is hardly a region in the whole world that has yet got the best combination of agriculturally useful genes in its grassland plants, while I make bold to hazard the opinion that there are many regions in the world that have not even yet got the right species to work. But of this again presently.

I am sure of this, however, that a general world interchange of commercial grassland seeds is bad for the grasslands of the world. It has admittedly done good in the past, it was necessary in the opening up of new countries, but it has also been responsible for a great deal of harm. I agree with Dr. Wilcox that "nations can live at home" in all manner of respects, and in no respect are they better advised so to do (and as far as possible) than in that of their grassland seeds.

I have implied that the first necessity is to map and classify our grasslands, and this is true the whole world over.

I regard this question of mapping of prime importance. We have mapped the whole of Wales, and my first intention was to devote my Presidential Address almost entirely to a detailed discussion of our methods—for I believe they are good methods and as methods are applicable the world over. Our maps are, however, on view at the exhibit, and I hope Mr. Davies, who has been primarily responsible for the methods and the work, and myself, will have the opportunities of explaining our aims and methods to those who are particularly interested, both around the maps and out on the hills and fields.

So much for mapping. I shall now venture some remarks upon the general problems of grassland, and all said and done, the basic problems are the same the world over. Of necessity I shall have to be selective and I conceive it as being my business to generalize, and as you will all have abundant opportunities amongst yourselves for correcting me, I shall not be afraid of generalizing here and there on insufficient evidence.

The outstanding feature of grassland is its complexity. It is impossible to isolate the factors, and I doubt if it will lead us very far if we attempt unduly to isolate the factors—on the farm and on the ranges all factors interact. Hardly ever do we attempt to grow a single grassland species by itself. I like to grow *Lolium italicum* by itself for winter keep, and we are here experimenting with growing *Phleum pratense* (our S. 48) in cultivated drills for winter keep, but this is incidental, and cannot now be discussed. As all of us grow at least 2 to 3, 4 or more species together to make a sward, competition always enters into the matter. And always, always, always there is the grazing animal.

Soil, climate, grazing animal. Which of these three is the most important factor? Most emphatically the grazing animal! Manure right, sow right and manage the grazing animal wrong and you are nowhere. Without the grazing animal there would be no grassland worthy of the name anywhere in the world. Management is therefore the key to the solution of the whole grassland problem. The real point is this, that the animal makes for itself its own grassland. It is because of this, that I say there are regions in the world not yet using the right species (apart from the right genes of the right species). By management entirely alter the conditions, make good lime deficiency, make good phosphatic, and if necessary poatssic deficiency, make conditions above everything favourable for a leguminous plant; make it possible to hold animals to the ground, and then you can begin to consider introducing and maintaining species hitherto unthought of.

I believe, and I say this is not lightly or without experience, that there are many range areas in the world where it would pay best and where more stock could be carried, and that stock in better health, if about three-quarters or more of the area were let go wild and completely unstocked, and if real and tremendous things were undertaken, on well-selected remaining areas. In effect, that is what we are doing here on the Welsh hills, and we are successfully

introducing proper grassland species, including, of course, wild white clover (*trifolium repens*), where such species have never before gained a footing. We talk about grass and grassland. No grassland is worthy of the name, and indeed is hardly worth bothering with, unless a legume is at work. Find or breed the right legume for every corner of the wôrld and you have tolerably good grassland in every corner of the world. Make the conditions suitable for the legume and manage the sward, to favour the legume as well as to feed the animal, and everything else will be easy—the battle will be won.

This is indeed a sweeping generalization, but prove me wrong who can, for not nearly enough work has been done in exchanging legumes all over the world, and in making conditions favourable for legumes or in breeding legumes.

So much for the geographical problem, as I see it; now for the domestic problem, the problem that affects everybody. The domestic problem is clearly threefold. *Firstly*, how to produce grass at those seasons of the year when it is most urgently wanted; *secondly*, how to use and to farm grass with a view not merely to maintaining, but with a view always and progressively to increasing soil fertility, and *thirdly*, how to manage grass so that the animal always has offered to it young, rapidly growing and succulent grass of maximum nutritive value.

The whole problem, I repeat, resolves itself into management. Each of the above desiderata calls first and foremost for rotational treatment. Rotational treatment of a farm as a whole, and of individual fields. *Rotation in time and rotation in space.* The always doing of something this month with a view to obtaining some definite result two or three months later. Always, too, the need of the sward must rank as of an importance at least equal to the day-by-day needs of the animal. By adopting a system of rotational grazing—intermittent with proper periods "on" and proper periods "off"—the animal can be given somewhere every day what it requires, and the swards need never suffer. One further point, swards will recover from the most villainous of malpractices if such malpractices are not too long continued, *and if they are not put into operation at precisely the same time of the year, year after year.* Hence the need for rotational management all over the farm. Incidentally, I may here interject that I do not hold with using fields continuously as pastures or continuously as hay meadows; to do so is an offence against the basal idea of *rotation in time*. For *rotation in time* I regard as the most fundamental of all grassland principles, and yet, and perhaps on most grasslands, especially on the ranges and open hills, the management is essentially the same month for month, year after year, for generation after generation. Ridiculous folly indefinitely perpetrated in the end enforces a heavy but just retribution, and all over the world millions of acres stand as doleful witness of agricultural practices conducted on a faulty and undeviating time schedule.

So much in general with reference to my three desiderata : now for the particular, and I will deal first with my *No. 2 Soil Fertility*, for in the last resort on this do "grass when it is wanted" and "succulent and nutritious grass" so largely depend.

I have said that to ensure soil fertility we need to marry our stock to the soil, and the cheapest and most effective way to do this is to plough up all grasslands that will take the plough at regular intervals. Always before ploughing up graze as hard as possible for some months, in order to impregnate the soil with urine and excrement—with what Mr. Bruce Levy so aptly describes as "stock nitrogen." Having turned the sod over, apply lime, harrow in, and you will have made and spread an admirable compost all over your field. Now do what you like. Cash this fertility, or some of it, where you can in a corn or other crop, or sow straight down to grass again and cash your fertility in more luxuriant grass and build up yet more fertility. I hold that permanent grass where it is possible and on all grounds reasonable to plough is wrong in theory, wrong in fact, is uneconomic and ridiculous. Of course, you cannot plough up all the permanent grass, grazings and ranges in the whole world, but with the tractor and modern implements you can plough in all manner of unheard-of places and under all manner of difficult conditions. Manifestly it would be madness to plough up many types of range country, as that would be to invite certain soil erosion, but such is far from true of all range country. And suppose you can establish a thicker sod than ever before, and establish it quickly, and in the non-erosion season. While with a view simply to the introduction of new species, it is often sufficient merely heavily to cultivate and scratch. Pray remember you can plough up and put straight down to grass again perfectly well, and pray remember also that the best top dressing of all is that put on the soil itself at the time of sowing seeds (I am not now referring to applications of inorganic nitrogen applied to bring grass at some wanted time). How often to plough up is a matter of circumstances and condition. Once in 100 years is better than never; once in twenty years better still, and once in ten years often quite sufficient. Plough more frequently than once in ten years and you begin to be scientific, progressive, and a farmer in very truth, for then amongst other things you can begin to avail yourself of the labours of the plant breeder, and if you do things properly you are going to build up fertility at a prodigious pace. You can farm on the basis of temporary leys of from one to six or eight years' duration, and produce productive grass at all those times of the year that climatic conditions permit stock to graze out of doors. The production of winter grass in telling quantity is, for example, a very real project under the climatic conditions of this country.

In regard to "grass when it is wanted" and "succulent and nutritious grass" I will be very brief, for I have already detained you far too long.

The production of short, succulent grass, and at times of the year when most needed, is a refinement of pasture management that is applicable in all its intricate complexity only to the true grassy-clovery swards of the more temperate

regions—to the fields of our farm lands. It is to grass of this sort that I am now explicitly referring—to grass in the main consisting of the well-tried European species tolerant to and actually thriving best under well regulated heavy grazing and heavy trampling, the species that call aloud for and prosper exceedingly only when amply assured of stock nitrogen.

The production of short grass is then just a matter of rotational and intensive grazing; of intermittent grazing with heavy urination, followed by adequate periods of rest. Once a year the plants must be allowed to grow away to permit adequate root growth. The botanical composition of any more or less permanent or long-duration sward will be a function (almost a direct function) of the times of the year it is grazed hardest, and of the times of the year it is rested. If on any field these times are the same year after year, the number of species will automatically become very restricted, and probably in the interest of the ration and of seasonal spread-over will become much too restricted and automatically less and less grass will be developed just when it is most needed. If you proceed to accentuate this time factor by applying nitrogen always at the same date, very soon you will kill out the particular species which respond best to nitrogen applied at that particular date—such species or strains will be literally grazed to death So once more I say, never on long-duration swards and on permanent pastures do the same things to the same date programme on the same field for over two years in succession—*rotation in time again!* It is often a very sound practice to adhere to a time schedule for two or even three years in succession on short leys (leys of up to three years' duration) for when you have ruined such leys you plough them up. Hence one of the outstanding advantages of short leys. Short leys are intended to do a certain thing, and when they will do this thing no longer you plough them up—and I daresay that is about the best of all rules for the management of the grass-lands of our farms.

Short grass at different and at all times of the year, and especially at the most difficult times—that is my last point, and I think the most important point of all, and it is one that offers tremendous scope for detailed research.

There are two main avenues of approach, the one by employing special seeds mixtures designed in the main to cater for a particular and short period of the year (once more the glory of comparatively short leys, and the justification of the plant breeder), and the other so to manure and so to rest particular fields that they do in fact have grass to offer at the particular date demanded by the grazing schedule.

I will give two examples of special "time" seeds mixtures. At this Station we advocate comparatively simple seeds mixtures, and we have achieved great success with one consisting only of our Station bred leafy perennial rye-grass (*Lolium perenne*) (Dr. Jenkin's S. 23), rough-stalked meadow grass (*Poa trivialis*) and wild white clover (*Trifolium repens*). In some years the sward so produced (as is common with *L. perenne*) tends to go short in July and August. We have

however found that another excellent simple mixture is one made up of our Station bred meadow fescue (*Festuca pratensis*) (S. 53) ; Dr. Jenkin's pasture-hay timothy (*Phleum pratense*) (S. 48), and wild white clover (*T. repens*) ; this gives palatable and productive grazing all through the season, and in July and August considerably outyields the *L. perenne* mixture. A mixture consisting of our Station bred *Alopecurus pratensis* (S. 56) ; our Station bred red fescue (*Festuca rubra*) (S. 59), and wild white clover (*T. repens*) remains wonderfully winter-green and gives an unusual amount of leafage in late February and during March—that is to cater for the winter.

As to resting for particular periods, I will take as my example the production of winter grass in this country, for our climate permits of out-wintering. We in this country are now drying spring and summer grass for the winter, and I am inclined to say why not grow winter grass for the winter and convert it *in situ* ? It can be done already, despite the fact that the plant breeder has hardly begun to show his hand in this matter.

What is wanted is winter-green strains and then the plan is to rest the fields completely as from about the middle of August or not later than towards the end of September. By the use of proper strains, resting at the right time and properly manuring, we here at Aberystwyth have obtained grass *in situ* available from Christmas to the end of March, with a crude protein content of from about 14 to as high as 20 per cent. of the dry matter. The yield per acre of this sort of grass then available has on occasion exceeded 3,500 lb. of dry matter. Thus with a range of fields a great deal of grass of high quality can be made available all the winter. Much better winter grass, and more of it, can be obtained from young leys sown with the right strains than from permanent pastures.

In our experience much better winter grass is obtained by resting a pasture which has been heavily grazed and saturated with stock nitrogen for some time than from an aftermath. If aftermath is wanted for winter grass such aftermath should not be allowed to grow straight on from after hay harvest, but the field should be grazed heavily as soon as it will hold stock after harvest, given a dose of "stock nitrogen" in fact, and then put-up for winter grass. At the time of putting up for winter grass we always dress with about 1 cwt. to the acre of nitro-chalk—as a supplement to stock nitrogen inorganic nitrogen is invaluable.

I have rather daringly covered a very wide field, and I have (although partly in the interest of brevity) most daringly generalized. I am sure you will appreciate the fact that anything of truth or value that I may have been able to say is due almost entirely to the untiring efforts and competency of my colleagues. They do the work, I do the talking. I am afraid I have talked almost solely around my own experiences and the work of my own Station. But nevertheless, and however unworthily expressed, I think I have said enough to justify the belief that all of us here present are engaged in the study

of a very great science; our concern is, however, much more than that; we are concerned also with a very great art, and more still, *this* our enterprise is of prime sociological significance and importance.

If the peoples of the world, and to a man, are indeed to be adequately fed with fresh food of the highest quality, and balanced in every respect, then the enormous acreage of the world that stands in grassland of every character, and of no character at all, must be brought to play its full part. It is not only grass itself that is so essential as a feed, but it is the whole acreage under grass that must be made to yield to more intensive treatment. To an ever-increasing extent this acreage must be made to produce better and better grass, and also other necessary crops.

THE BORING POINTS FOR REFRACTOMETER TESTS OF SUGAR-CANE.*

BY

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AND

H. B. SINGH,

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The Zeiss Refractometer has been adopted in British Guiana for the purpose of testing sugar-cane fields prior to harvest, and of guiding the selection and discarding of seedlings at the cane-breeding station. Under the latter conditions it was soon found that while the co-efficient of correlation was high between the brix of expressed juice and the total solids as determined by refractometer readings on composite samples from borings made in the top, middle and bottom thirds of the stalks, the absolute values did not correspond as closely as was desirable. An investigation was therefore undertaken to determine if there was any fixed point or points in the stalk which would yield a refractometer reading identical, or nearly so, with the true mean brix of the stalk.

The work was carried out on plant canes of three varieties (P.O.J. 2878, Diamond 10 and D. 66/30) and in duplicate on each variety. The procedure adopted was to select from the same field of any one variety, five stalks having eleven internodes (joints), five having twelve internodes, five having thirteen internodes, &c., &c. On arrival at the laboratory, the tops (cabbage) of the stalks as far as the first joint below the point of attachment of the oldest green leaf-sheath were discarded. Then for each batch of five stalks the internodes were milled separately, *i.e.*, the five topmost (second) joints together, the five next joints together and so on until the bottom or older end of the stalks was reached.

The per cent. total solids in juice for each batch of joints was determined, and by noting the weight of the juice extracted it was possible to calculate a weighted mean total solids for the whole stalk. All that was then necessary was to note at which joint or joints the per cent. total solids corresponded with the mean figure for the whole stalk. The results obtained are presented in Table I.

It will be seen that in stalks of all lengths from fifteen to twenty-four internodes (joints) and of all three varieties tested, the per cent. total solids of the juice from the seventh or eighth joint below the point of attachment of the lowest green leaf-sheath corresponds closely and consistently with the mean total solids of all the juice from the stalk.

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*Reprinted from *Tropical Agriculture*, Vol. XIV, No. 11, pp 313-315, 1937.

In the case of the shorter (younger) stalks, having from eleven to fourteen joints, the location of the joint with the true mean total solids is somewhat higher up the stalk, *i.e.*, at the fifth and sixth joint below the point of attachment of the oldest green leaf-sheath.

In the longer (older) stalks a joint near the bottom of the stalk (about the sixteenth to the eighteenth joint below the point of attachment of the lowest green leaf-sheath) also tends to yield a juice whose total solids corresponds with the mean for the whole stalk, but the exact joint cannot be defined with as much accuracy as the higher one and does not appear to occur at all in the younger stalks.

Table II shows a typical set of readings for two groups of five canes. They show that the difference in total solids between the fifth and sixth joints, or between the seventh and eighth joints is slight. Observers can therefore decide on a definite point (say the sixth joint for canes having from eleven to fourteen joints and the eighth joint for canes having from fifteen to twenty-four joints) and expect a reasonably high degree of accuracy in the results.

An investigation of this nature incidentally reveals what point of the cane stalk has the highest solids content. It was found that as far as the shorter canes (11 to 14 joints) are concerned, this is located at the base whereas in canes with longer stalks (15 to 24 joints) it tends to occur approximately in the middle of the stalk.

TABLE I.

LOCATION OF JOINTS OF CANE STALKS WITH PER CENT TOTAL SOLIDS CORRESPONDING TO MEAN TOTAL SOLIDS OF ENTIRE STALK.

STALK OF	Number of Joint Below the Point of Attachment of the Oldest Green Leaf which may be Bored to Secure a Refractometer Reading Corresponding to the Weighted Mean Solids of the Whole Stalk.			
11 Joints	5.57	±0.19		
12 do.	5.83	±0.15		
13 do.	7.00	±0.25		
14 do.	6.25	±0.68		
15 do.	7.87	±0.28		
16 do.	7.28	±0.33		
17 do.	8.11	±0.53		
18 do.	7.75	±0.29		
19 do.	7.89	±0.35	16.7	±0.63
20 do.	8.89	±0.46	15.5	±1.06
21 do.	7.85	±0.60	18.0	±0.62
22 do.	7.25	±0.42	16.3	±0.61
23 do.	7.25	±0.76	17.0	±1.00
24 do.	8.14	±0.59	18.0	±1.17

TABLE II.

TWO TYPICAL SERIES OF REFRACTOMETER READINGS.

Joint No.	Five 12-Joint Stalks of D. 66/30.			Five 21-Joint Stalks of Diamond 10.		
	Refractometer Solids.	Total Weight of Juice from 5 Joints, lb.	Total Solids from Juice, lb.	Refractometer Solids.	Total Weight of Juice from 5 Joints, lb.	Total Solids in Juice, lb.
1 ...	This Internode was discarded with top (cabbage.)					
2 ...	16.6	0.75	12.450	18.8	0.75	14.100
3	16.9	0.75	12.675	17.8	0.75	13.350
4 ...	17.3	0.75	12 975	18.5	0.75	13.875
5 ...	17 8	1.00	17.800	19.0	0.75	14.250
6 ...	18.0	1.00	18 000	19.2	0.75	14.400
7 ...	18.4	1.00	18.400	19.2	0.75	14.400
8 ...	18.4	1.00	18.400	19.0	1.25	23.750
9 ..	18.7	0.75	14.025	18.9	1.00	18.900
10 ...	18.9	0.75	14 175	19.0	0.75	14.250
11 ...	19.1	0.50	9.550	19.8	0.50	9.900
12 ...	19.7	0.25	4.925	20.2	0.50	10.100
13 .	...	Total = 8.50 Weighted Mean Refractometer Solids = 18.04	Total = 153.375	19.8	0.75	14.850
14 ...	...			19.8	1.00	19.800
15 ...	...			19.6	0.75	14.700
16 ...	...			19.8	0.75	14.850
17 ...	...			19.6	0.75	14.700
18 ...	...			19.2	0.50	9.600
19 ..	...			19.4	0.50	9.700
20 ...	...			19.7	0.50	9.850
21 ..	...			19.8	0.50	9.900
					Total = 14.50 Weighted Mean Refractometer Solids = 19.26	Total = 279 225

SUMMARY.

An investigation to determine what joint or joints in a sugar-cane stalk had a total solids content corresponding with the weighted mean total solids of the entire stalk is described.

It is shown that under British Guiana conditions an accurate reading may be obtained from the fifth or sixth joint below the point of attachment of the oldest green leaf-sheath in the case of canes having from eleven to fourteen joints; and the seventh or eighth joint in the case of canes having from fifteen to twenty-four joints.

It is also shown that no corresponding joint with the mean total solids occurs in the lower (older) portion of the stalk of canes having from eleven to eighteen joints, but that such may be found in the canes having from nineteen to twenty-four joints. The location of this joint is, however, more reliable to fluctuation, and observers may better rely on the joint with the mean total solids in the upper portion of the stalk.

ACKNOWLEDGMENTS.

The writers are indebted to Mr. C. Holman B. Williams, Agronomist in charge of this Station, for his advice during the progress of the work and his suggestions with regard to the presentation of the results.

COFFEE QUALITY

The task of elucidating the factors that govern coffee quality is beset with difficulties. Good field husbandry and factory practice can contribute much in giving the desired size, colour and evenness to the raw coffee; the special requirements of the roast are more difficult to attain, whereas little is known of the conditions that make for the desired acidity, body and flavour of coffee in the cup. The main difficulty in correlating the liquoring properties of coffee is that it has not been possible to define liquoring properties in chemical terms. The personal equation of the taster also plays an important rôle, thus making it difficult to standardize any coffee samples under consideration.

The scientific literature on the subject of coffee liquor is scanty and not very helpful, as it usually gives no useful clues that may lead to direct methods of investigating the true meaning of differences in the liquoring properties of coffee. Such differences, which often vary greatly between neighbouring estates, play a profound part in the economy of coffee production, more especially in East Africa, where such a wide range of prices obtains. The necessity for making some progress towards the solution of this intricate problem has now become urgent.

The outlook for making early progress by studying the nutrition of the coffee tree or by comparing bean analyses with unstandardized terms of liquor, offers little promise. It is therefore pleasing to read an account of some headway in the matter of elucidating coffee quality that has been made by investigators in Brazil and Costa Rica.[1] The purpose of this note is to draw special attention to these coffee quality investigations and to discuss their possible application to the coffees of East Africa.

An account of certain Brazilian investigations dealing with the effect of harvesting and factory methods on coffee quality may be summarized as follows:—

1. When cherries were allowed to dry slowly on the tree in normal, harsh, or "Rio-flavoured" regions, the resultant coffee was harsh, whereas similar drying on the tree in recognized mild-flavoured areas gave a mild coffee. With such slow drying of the cherry, the specific natural flavours are retained in the properly prepared coffee.

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* Reprinted from *East African Agricultural Journal*, Vol. III, 2—September 1937

[1] "Recent Efforts for the Improvement of Brazilian Coffee", in the *Monthly Bulletin of Agricultural Science & Practice*, Int. Inst. of Agric., Rome; January 1937.

2. It was found also that cherries from regions known as good gave a coffee of mild beverage only when subjected to correct harvesting and factory treatment. This consists in the main of slow drying with constant stirring of completely ripe-picked cherries such that *no fermentation of the pulp occurs.* When such correct methods were neglected, and mixed stripped cherries, even from regions famous for high quality, were allowed to ferment in the pulp, the resulting coffee was inferior in beverage. In the above two investigations it will be noticed that the coffee was prepared by the normal Brazilian method of drying the coffee in the cherry and then decorticating.

3. Another investigation compared the quality of coffee from different sources, when prepared by pulping the cherries and then washing and drying the beans. It was found that all samples pulped, from every region, always gave a mild beverage. The control samples, which were not pulped but were allowed to ferment in the cherry, gave a beverage with a disagreeable flavour varying with the degree of fermentation that had taken place.

4. A further test in tracing the harsh or mild quality of coffee was carried out by spraying cherries of known poor quality, while on the tree, with a sugar solution containing cherry yeasts which are normally associated with high quality. It was found that there was a difference in the quality of the coffee from the sprayed trees. The sprayed cherries never had the harsh or "Rio" flavour.

5. The effect of inoculation with a more suitable micro-flora was tested by adding the pulp of cherries from a plantation yielding mild coffee to fermenting cherries from a plantation known for its "Rio-flavoured" products. It was found that the resultant coffee had a pronounced mild flavour.

In the Costa Rica investigations, using the wet fermentation method of preparation, it was found that when pulp from a superior quality coffee was added to another fermenting pulped coffee, the resultant beverage was of a higher quality.

It had been thought that the harsh or "Rio" flavour, characteristic of coffee originating from certain defined regions in Brazil, was due to the nature of the soil. The above investigations, carried out independently in Brazil and Costa Rica, showed that by proper treatment it is possible to produce mild coffees in the regions hitherto known for their harsh coffees. It has been shown that the nature of the fermentation and the resulting quality depend largely on the specific yeasts that predominate in the micro-flora of the coffee cherry.

It is supposed that the products secreted by the organisms in the pulp have a profound influence on the quality of the coffee bean, as the cell wall of the latter is more or less permeable to secreted ferments. It is believed that the yeasts secrete a ferment which penetrates the beans and provokes the mild flavour, or else that they secrete something specific which inhibits the activities of other less suitable organisms which are normally responsible for the harsh "Rio" flavour.

A survey of the predominant micro-flora, in good and bad plantations respectively, showed which were the most beneficial, and pure cultures were separated out. It has been shown that when such pure cultures of yeast are added to previously sterilized cherries, the fermenting processes and also the resulting flavour of the beverage are altered. The practical application of this study lies in altering the micro-flora living on the cherry and thus forming associations in which the beneficent yeasts of high quality coffee predominate.

It will be appreciated that the above-mentioned results, quoted by M. Rogerio de Camargo of Brazil and Dr. C. Ricardo of Costa Rica, offer a direct line of approach for investigating variations of coffee quality in East Africa. They appear to offer more promising lines of approach than bio-chemical studies of the metabolism of coffee bushes and analyses of coffee beans, when one considers that analytical data need not necessarily explain the finer differences in the liquor of samples of coffee. Again, field and factory trials involving inoculation with the predominant micro-flora living on certain cherries or pulp are such that they can be initiated in a simple manner. Then, if these tests show sign of promise, they could be followed up with a field survey of the types associated with good and bad liquor and pure cultures of beneficial micro-flora could be separated out.

Lest the above investigations should lead to too optimistic views being held about the possibilities in East Africa, it might be well to refer to some of the major difficulties involved. In the first place, the work dealt mainly with the extremes of harsh or "Rio-flavoured" coffee against Brazilian mild coffee, whereas here we have to deal with differences of liquor within a series of mild Arabica coffees. The Brazilian investigations again deal largely with coffee that is stripped off the trees, dried and decorticated—it being found that pulped and washed coffee always gave a milder flavour. However, work in Costa Rica has shown that the addition of selected pulp can improve the quality even of coffee prepared by the wet method, so that it may be found that fermentations produced by various micro-flora may have an effect even with the East African mild series.

Those working on coffee in East Africa are indebted to the American workers for thus indicating a possible direct line of approach in investigating the quality of local coffee, and it is to be followed up by the Kenya Coffee Team with the coming crop.

NOTES.

Bronze-Leaf Wilt Disease of the Coconut Palm.—For many years past coconut palms in Trinidad have suffered from a disease to which the term "Bronze Leaf Wilt" has been applied. The Department of Agriculture recently published a bulletin prepared by F. M. Bain on this subject. Thousands of palms have died as a result of this trouble, and the position as regards coconut growing is such that, with the exception of estates situated on the more favourable sandy coastal belt, large tracts of coconuts in many areas are threatened with extinction within the next few years. This disease occurs in British Guiana and is responsible for the loss of many trees on soils unsuitable in regard to texture.

DESCRIPTION OF THE DISEASE.

The usual age at which trees die from the disease is fifteen to eighteen years. The three lowest leaves of bearing palms, which usually appear quite normal and healthy previously, are observed to have taken on a yellow and bronze colouring, the colour proceeding from the tips of the leaflets backwards. At the same time the tips of the next two or three leaves are seen to be yellowing, the extent of discoloration increasing with increase in the age of the leaf. The yellowing of the leaf extends up to still younger leaves, but long before the youngest leaves show discoloration of any kind a rot sets in at the base and in the folds on the leaflets of the central spear of leaves. The rot later extends into the cabbage. This rot develops to a considerable degree before the central spear of leaves changes colour, but in the later stages of the rot they wilt, turning a dull greyish-brown colour and fall over at the base. Shedding of nuts takes place at the same time or slightly in advance of the discoloration of the leaves; the youngest nuts being shed first. The oldest inflorescence on the tree is seen to be changing to a brown colour, in some cases even before the spathe has opened.

In some instances palms which have shed their nuts are to be seen with healthy inflorescences. This occurs after an extended drought period and then palms recover with the advent of the rainy season. Such palms may be found in situations where "Bronze Leaf Wilt" does not occur.

It will be seen that the *external* symptoms of this disease are identical with those of "Red Ring", which was shown by Nowell to be caused by the nematode *Aphelenchus cocophilus.*

SOIL STUDIES.

In 1928 Briton-Jones suggested that a soil factor is responsible for the disease, since both he and Nowell were unable to associate any organism with the disease except as a secondary infection. Soil studies therefore formed the basis of this investigation.

A general soil survey gave no definite correlation between soil type and incidence of the disease. Examination of soils from "Wilt" and "Wilt-free"

areas for texture, organic matter, nitrogen, carbon : nitrogen ratio and available phosphate showed no marked differences. Generally speaking, the soils of the good coconut areas show more available potash than those of the " Wilt " areas, but the difference was not sufficiently large or consistent to account in itself for the disease. Weekly fluctuations in soil moisture, soil nitrate and water table were studied over a period of eight months, which included both wet and dry seasons, but abnormally wet weather during this particular period detracted from the value of the results. Further moisture determinations, however, during more normal weather, gave indications of a greater conservation of moisture in the sub-soils of healthy areas than in the contrasted wilt areas.

Consideration of the physical conditions and allied water relationships of the soil led to a classification of wilt soils which clarified the problem considerably. Three types were recognised :

I. Surface soil is close textured and overlies a sub-soil which is impervious to water. Such a soil is subject to waterlogging during wet periods and liable to dry out quickly in the surface soil during periods of drought.

II. (a) Soil and sub-soil are open-textured and free-draining. This leads to a relatively poor water supply during dry weather.

(b) Soil and sub-soil are compact and dry out quickly in times of drought.

III. Friable top soil with an intolerant sub-soil layer.

ROOT STUDIES.

(a) Root system of trees in healthy area : root development in the first foot was very great, many branch roots and feeding rootlets being observed. The number of roots decreased gradually in the second and third feet but was still appreciable. In the lower depths to six feet there were still roots to be found, the majority within a six-foot radius of the bole.

(b) Root system of trees on soils of Class I : root development in the first foot was very good, many feeding rootlets being observed. In the second and third feet, the development was generally good, but in some instances a few rotting roots were observed near the bole of the tree. Below this layer the soil was waterlogged and a mass of rotted roots was encountered.

(c) Root system of trees on soils of Class II : root development in this case was observed to a depth usually about four feet. The numbers of main and branch roots as well as feeding rootlets were much less than in the case with trees growing in healthy areas. The depth of penetration was also much less.

(d) Root system of trees on soils of Class III : this class refers to soils of the Princes Town Marl type. Root development is comparatively good until the marl layer is reached. Very few roots penetrate into this layer. Where wilt occurs the marl layer is usually at a depth of two or three feet. Where the layer is deeper, wilt is apparently not very prevalent.

LEAF ANALYSES.

Leaf samples were collected for analysis to see whether any differences in the nutrient status of plants growing on contrasted healthy and wilt areas could be revealed. It was found that, in general, the nitrogen status of palms in wilt areas tends to be higher, and the phosphate status lower, than for palms in the healthy areas.

CAUSE OF THE DISEASE.

In considering the soil data, the physical nature of the soil was found to be the most important factor. From general field observations, incidence of the disease is most marked during period of drought, but measurements of the available soil moisture in the top two feet of contrasted healthy and wilt areas brought out no differences sufficient to explain the disease. It appeared, therefore, that any difference must occur in the soil below two feet. Root studies showed differences in the plants grown in the various soil classes, and indicated that the water relationships were such as to hinder root absorption at certain periods. Previous to wilting, the palms show very fine vegetative growth, and this explains their high nitrogen status. as found by leaf analyses.

The disease can now be explained on all three soil types :

Class I Soils—Close textured surface soil overlying an impervious sub-soil. At the beginning of the rains the trees increase their absorption of water and nutrients, giving good growth and a healthy appearance. As the rains increase the impervious nature of the sub-soil causes a temporary water table to be formed. As this water table rises the subsurface roots are submerged, and finally die and rot. The surface roots, however, continue their absorptive function. During the ensuing dry period the surface soil dries out rapidly, and roots in this area can function at most very feebly. In the sub-soil, where there is ample moisture, roots have been killed out and hence no absorption can take place. The result is water deficiency in the plant, which, combined with the increased transpiration during dry weather, causes "Bronze Leaf Wilt". During its youth there may be sufficient moisture all the year round to satisfy the requirements of the tree, hence "supplies" on this area look promising.

Class II Soils—Surface soil and sub-soil open textured and free draining. During rainy periods there is a constant supply of water, and absorption progresses favourably, but during a prolonged drought the soil dries out rapidly to a great depth, and the water supply may be reduced to the wilting point.

Class III Soils—Friable topsoil with intolerant sub-soil layer. General conditions are similar to those of Class I soils. Palms make exceptionally good growth in the early years, but the root system is restricted by the intolerant layer and a stage is reached where it cannot meet the nutrient requirements of the tree.

METHODS OF CONTROL.

Class I Soils—More efficient drainage, and trenching with organic materials would produce a more even supply of soil moisture throughout the year. Where such treatment is uneconomic, a change of crop is recommended, sugar cane being the most suitable substitute.

Class II Soils—Where possible, irrigation should be practised, but conservation of the soil moisture might be attained by trenching with pen manure, husks and other organic matter. In view of the poor nutrient status of these soils, the application of fertilizers, particularly potash, is recommended.

Class III Soils—The depth of the intolerant sub-soil layer is the controlling factor, and no economic remedy can be suggested. Where coconuts are not profitable another crop should be grown. D.W.D.

Rotenone Yielding Plants of South America.—A most interesting paper on these plants by B. A. Krukoff and A. C. Smith has recently been published in the *American Journal of Botany* (Vol. 24, No. 9, 573-587, November 1937). These workers have had many opportunities of examining in the field the species of Lonchocarpus, etc., from which the natives of different parts of South America extract fish poisons, and some of which have recently acquired a commercial value on account of their content of rotenone and other extractives which are valuable as insecticides. As a result of their collections and observations they have now been able to make an important contribution towards the correct botanical determination of these plants, which have hitherto puzzled botanists working only with Herbarium material. Owing to the facts that some of the species of Lonchocarpus are seldom found in flower, that the species concerned are much more numerous than was realised by early workers, and that considerable variation may exist in leaf characters of the same species when the leaves examined are from old or young portions of the same plant, or from plants grown under different conditions, it has been impossible for systematists working with scanty material to distinguish correctly the different species concerned.

In their paper, Krukoff and Smith describe one species of Derris, and nine species of Lonchocarpus, including three new species which are described and named, and two species, the vegetative features of which are described but which in the absence of flowers cannot yet be named.

The cultivated barbasco or cubé of the Amazon basin, known in recent years as *Lonchocarpus nicou* (Aubl.) DC, has been recognised as differing from the original plant described by Aublet on which the species was based, and has been named *L. utilis* A.C. Smith, sp. Nov. The other important rotenone yielding plant of this area, timbo, is *Lonchocarpus urucu* Killip and Smith.

Of more immediate importance to this Colony is the recognition that the Haiaris, recently considered also to be *Lonchocarpus nicou* and therefore conspecific with the powerful poison plants of the Amazon basin, are in fact different species, thus readily accounting for the fact that they have a very much lower rotenone content than cubé. The White Haiari, which is found throughout British Guiana, has been named *L. Martynii* A. C. Smith sp. Nov., and the Black Haiari, which appears to be well distributed in both Surinam and this Colony, is recognised as *L. Chrysophyllus* Kleinh., though it is possible that this name may have to be revised when further flowering and fruiting material, which is very rare in the case of this species, has been found.

E.B.M.

Surinam and Curacao.—In the *Times Trade and Engineering* of December 1937, Dr. M. van Blankenstein writes an informative article on these Dutch colonies in the Caribbean. Surinam is a part of the South American continent, with British Guiana, French Guiana and Brazil at its boundaries. Except for the narrow, populated strip along its coast it is covered with jungle and savannah.

The soil of the populated area is fertile. In the interior many valuable tropical woods are found. Gold deposits, which have been exploited more or less successfully for many decades, are found in widely scattered parts of the land in the form of veins in rocks or in the mud of creeks. The most important source of income for the country is, at present, another mineral—namely, bauxite, raw material for the manufacture of aluminium. High-grade iron-ore is also found in Surinam. Rivers facilitate transport across the populated area, which, however, has only 150 miles of serviceable roads.

In the eighteenth century Surinam was a source of wealth for the Netherlands. The beautiful patrician houses bordering the canals of Amsterdam are built with money derived more from Surinam than from the East Indies. There was an old and exceedingly rich class of plantation owners in Surinam who had immigrated during the seventeenth century. Their descendants are still in Surinam, but by the beginning of the nineteenth century they had lost most of their wealth and in many cases their plantations. The cultivation of cotton and sugar was ruined, that of cotton coming to an end with the competition offered by North America, while other agricultural activities languished after the abolition of slavery in 1863, not so much because of the abolition itself as owing to the bad management which followed it.

From this time onward Surinam has been struggling with a population problem. The country is as large as Java; but Java has now 45,000,000 inhabitants while Surinam has only 165,000. There are many different races of people. With the abolition of slavery, Chinese were imported as workmen. Many of them remained in the country and today they constitute 1½ per cent. of the population in the form of a middle-class. Later British-Indians were imported in great numbers and many of them, too, have climbed up into the middle-class, but since 1918 British-Indian labour has no longer been obtainable. Nevertheless the British-Indians constitute 27 per cent. of the population. Of much importance are the Javanese, who, when their contracts have expired, either return again to their native country or receive a holding as small farmers in Surinam. They already form 23 per cent. of the population and their number is increasing. The majority of the people of Surinam is, therefore, Asiatic.

This large country with its small population has for many years cost Holland more than 3,000,000 guilders a year in the shape of various contributions, and the revenues do not offset this expenditure. Many enterprises which have been started have turned out to be unsuccessful. How the old agricultural prosperity collapsed has already been told. The cocoa-tree promised, at the beginning of this century, new wealth to the country, but when everything was

thriving a devastating disease (Witch Broom) affected the trees and put an end to all hope. Subsequently the banana promised to bring prosperity, but another epidemic of disease (Panama Disease) completely destroyed the plantations.

One failure followed after another and the country suffers from lack of population. The beautiful wood in the forests cannot be systematically exploited ; the iron ore is not transportable ; and for balata there is little demand. The gold, too, has brought with it many bitter disillusions. There is no better characterisation of Surinam than as the land of great but economically unexploitable possibilities. Hopes are now focused once again upon banana cultivation and upon the export of citrus fruits which thrive well in this country.

Although "negro-English," the language of the slaves, is still the language of the lower classes and the "lingua franca" of the islands, the whole population and even the Negro and Red Indian children are educated in the Dutch language. Education is compulsory and the primary language employed by schools is Dutch. The non-Asiatic population is chiefly of the Protestant religion.

THE ANTILLES.

The Antilles, a group of islands with Curacao as the main unit, offer a great contrast in all respects to Surinam. The earth is barren, water is scarce, and there are no mineral deposits. The native language is Papiamento, a Spanish dialect. The population is Roman Catholic. There has been no importation of Asiatic peoples worth mentioning. Since the conquest of the island from the Spanish in 1636, Curacao has remained Dutch territory. Like Surinam, the colony was long poor, and only less expensive to the Motherland because of its smaller population and smaller area, but when the Shell and Standard Oil groups established there their great refineries for Venezuelan oil, a period of prosperity began for Curacao. Even the great world economic crisis could not affect it seriously. It is Curacao's advantageous position in relation to the Panama Canal which has made this development possible. Curacao eclipses Amsterdam many times in the volume of shipping directed to the port, and in terms of tonnage Curacao is now the second seaport in the Dutch Empire. The oil industry and shipping maintain the entire population. The colony is no longer cause for budget worries.

Both the West Indian Colonies belonging to the Kingdom of the Netherlands have, therefore, their tradition. The Dutch people have become accustomed to spend with inexhaustible resignation a great deal of money on Surinam, poor but nationally closely connected with Holland, and to hear of nothing but prosperity in connexion with Curacao.

Soil Erosion.—The following are two extracts from a recent article by Sir Frank Stockdale, K.C.M.G., K.B.E., in the *Emp. Jour. Exptl. Agr.*, October, 1937, on the problem of soil erosion :—

West Indian Dependencies.

Very little attention has been given to soil erosion in these dependencies and generally speaking the loss of soil from this cause has not been as excessive as it has been elsewhere, mainly because clean weeding has never been adopted as an agricultural practice, and planting in holes has been general. Sugar-cane is planted in holes or furrows, and in the cultivation of many food crops the system of preparing holes and mounds is fairly common. In some of the mountainous islands with heavy rainfall, erosion has, however, been serious, and it has recently been recognised, in St. Vincent for example, that considerable erosion is taking place. In Jamaica, moreover, the position is serious in the Blue Mountain range, and has not received the attention it deserves. It is, indeed, fortunate that the calcareous soils of Jamaica do not erode readily as little or no attempt is made to check erosion, but the soils in the Blue Mountain range area derived from schists are easily erodible, whilst uncontrolled deforestation has been permitted to proceed too far in the island.

In St. Vincent, soil erosion can be really serious, and one or two small-holding settlement schemes have, in the Cumberland Valley of that island, been established on lands situate on hill slopes which should have been kept in permanent forest cover. The condition of these small-holders, after some years on land of inferior quality subject to continued erosion can well be imagined, and it is to be hoped that in all future settlement schemes attention will be given to the selection of land of good average quality, and that no scheme be started until a satisfactory report on the land has been obtained from the Department of Agriculture. In St. Lucia, attention has recently been called by Mr. Wimbush, in his report on the forestry position in the Windward and Leeward Islands, to the unsuitability from the stand-point of erodibility of certain lands recently selected for development, and a re-consideration of the project has resulted in a revision of the proposals.

In Trinidad, the Imperial College of Tropical Agriculture is studying the amount of erosion on certain soil types in connexion with investigations relating to shifting cultivation.

More attention should, however, be directed to the question of soil erosion in all the wetter and more mountainous islands in the West Indies, and all Colonial Agricultural Scholars should, whilst at the Imperial College of Tropical Agriculture, have their attention specially directed to the question.

General Conclusions.

An attempt has been made to survey the present position in regard to soil erosion in the Colonial Empire, to describe the measures which are being taken to check and control its effects and to indicate where further efforts are required.

The most serious losses are taking place in East Africa, particularly in Kenya. Here the condition of some of the Native Reserves is becoming serious and deterioration is proceeding apace. It is the most important land problem which the country has to face, but if active steps are taken without delay the

position can be greatly improved within a decade. The actual causes of erosion are numerous and varied, and each drainage area of any country requires close examination before plans of reconditioning or control are decided upon. Untutored agricultural operations are responsible for erosion in many parts, whilst in others concentrations of stock numbers due to a shortage of grazing or inadequate water supplies are the chief contributory causes. In yet others, stock numbers are in excess of the carrying capacity of the land and overgrazing takes place. Rotational or deferred grazing has been demonstrated to be effective as a cure in certain circumstances, and strip-cropping, contour-ridging, and mulching have proved their value in agricultural lands. There are many instances where deforestation has been excessive, and considerable areas of land may have to be retired from cultivation or grazing if the position is to be improved.

The problem is one which must be approached from various angles. Physical, biological and social factors have to be considered, and there is no doubt that the fullest co-operation between the administrative and technical departments is essential if advances are to be made. Generalizations as to control measures must be avoided. Each area should be examined in detail and working plans evolved before any decision is taken as to how the problem should be tackled.

Vegetation-control is the most important method of controlling soil erosion, since it produces a cure by natural methods and is much less expensive than treatment by mechanical means. In cultivated lands on hilly slopes, however, the use of contour-ridges, terraces, hedges and drains is necessary when strip-cropping cannot be adopted, if the fertile top soil is to be saved.

The use of control measures, without an improvement in the systems of agriculture and animal husbandry, is likely to be unsatisfactory. Such a policy meets only the circumstances of the present and does not provide for the future. Expenditure on anti-erosion measures should at least be matched with expenditure of a similar magnitude for agricultural education, demonstration and propaganda, if the future is to be secured.

Clarification of Sugar Syrups.—In the December 18, 1937 number of *Chemistry and Industry*, A. Nagaraja Rao and B. S. Gupta published the following letter on this subject :—

Considerable difficultly is being experienced in the preparation of concentrated, clear and brilliant syrups from most of the sugars manufactured in India. Repeated treatment with large amounts of activated carbons, followed by more than one filtration, has been found to solve the problem partially. It is, however, still believed that the syrups made from imported sugars are far more satisfactory.

The manufacture of concentrated, clear and colourless sugar syrups is of great industrial importance and the utilization of Indian sugars (even the lower grades) for this purpose has been investigated in this laboratory for some time. We are glad to report that a new method developed by us has been found to be very satisfactory.

The syrup is treated with just the minimum quantity of sodium aluminate and activated carbon and then a current of carbon dioxide is passed through it to saturation. After allowing the mixture to stand for some time (about 15 minutes), the mixture of aluminium hydroxide and active carbon is removed by filtration to obtain a satisfactory syrup. It would not be out of place to mention here that the application of similar methods is being tried by us, also for the clarification of the different products in the various stages of the sugar industry.

Aluminium hydroxide has already been employed before for similar purposes by others, but there is always a definite advantage gained in the method indicated above over the others, in that here the amount of aluminium left over in the filtrate (syrup) has been reduced to the minimum. Besides, in this method the active aluminium hydroxide is generated *in situ* and well mixed up with the active carbon thereby enhancing its decolorization property also.

Legislation.—The following have been appointed Inspectors in the terms of Section 19 of the Plant Diseases and Pests (Prevention) Ordinance, 1935 :—

The Director of Agriculture
The Deputy Director of Agriculture
The Entomologist
The Botanist and Plant Pathologist
All Agricultural Superintendents, Assistant Agricultural Superintendents and Agricultural Instructors.
Technical Assistants to the Entomologist and Botanist.

An Ordinance to provide for the control of Sugar Experiment Stations for a period of five years from the first of January, 1938, has recently been passed.

In accordance with Section 3 (1) and (3) of the Animals Diseases Ordinance, 1936, the following list of Registered Veterinary Surgeons was recently published for general information.

Name	Date of Registration	Address.
Benjamin, Charles Bishop ..	27.10.1909	Plaisance, E C., Demerara
Bruce, Samuel Nathaniel, D V M .	16. 4.1920	127, Lalum Street, Georgetown.
Fraser, Hugh Arthur, B V.Sc. ..	12. 9 1933	5, David Street, Kitty, E.C., Demerara.
Fulton, Andrew McPherson, D.V H., M.R C.V.S. ..	5. 7.1924	Vryheid's Lust, E.C., Demerara.
Hansraj, James .. .	27.10.1909	Agricola Village, E.B., Demerara
Kerry, Robert Retna	27.10.1909	Peter's Hall, E.B., Demerara.
Khan, Eli Baksh	27 10.1909	Public Hospital, Georgetown.
Larrouy, Francis Isadore .	26. 5.1909	Messrs. Brodie & Rainer, Georgetown.
Mitchell, Henry Alfred	20. 8.1909	31, Camp Street, Georgetown.
Bone, Thomas, O.B.E., M.R C.V S ...	19 9 1928	Department of Agriculture, Georgetown.

REVIEW.

The Practical Aspects of Copra Deterioration : by F. C. Cooke. Bulletin No. 28, General Series, Department of Agriculture, Kuala Lumpur, F.M.S. 49 pp. Price 50c.

The author is to be congratulated on a bulletin which should be of the greatest value to copra producers. Like good copra, it is clear and compact, free from the excess moisture of verbosity and the disfiguring mould of unnecessary technicality. Although the basis of the work is essentially chemical, only the practical applications and arguments are shown, and these make straightforward reading. Any attempt to summarize the bulletin would be futile, since it is in itself a summary, and its range can be seen from the section headings given below.

Part I. Introduction : moisture content and quality : the range of quality : the marketing of copra · conclusions.

Part II. Copra Deterioration : review of previous literature : the characteristics of deterioration : agents of deterioration : deterioration due to moisture : deterioration due to smoke and heat : the production of "smalls", fractures and dust : variations in the oil content

Part III. The Prevention of Deterioration : analysis of the causes of deterioration : the prevention of deterioration—pre-treatment of nuts, copra drying, after-treatment of copra.

Part IV. Copra Grading field and laboratory grading : commercial grading.

Not a word is wasted, and for that reason it requires careful study, but the time and effort will be well spent.

D.W.D.

MINUTES OF THE FIFTEENTH MEETING OF THE BRITISH GUIANA BEEKEEPERS' ASSOCIATION HELD AT THE HEAD OFFICE, DEPARTMENT OF AGRICULTURE, GEORGETOWN, ON MONDAY, JANUARY 24.

PRESENT.

Mr. E. A. Borman,	....	*President* (in the chair)
Prof. J. S. Dash (Director of Agriculture), Messrs. E. S. Vieira, C. A. Quail, M. P. Correia, D. M. Khan, Robert Williams, E. S. Christiani, Jr., D A. Hoo, W. M. A. Roberts, M. J. Henriques, J. G. Martin, C. C. Dowding, K. W. Ferdinand, H. Chand, H. Madramootoo, G. W. Roberts, N. A. Rickford, A. Hu-a-Kam, Mrs. I. Tjon-a-Man and Miss H. L. Ferdinand	....	*Members.*

with

Mr. H. D. Huggins	....	*Secretary.*

Excuses for their absence were received from Messrs. J. W. Perry, J. C. DaSilva, J. A. Trotman, Mohamed Ishak, W. Humphreys, D. A. Pile, K. C. Bose, P. A. Hoo and S. A. King.

MINUTES.

The Minutes of the previous meeting held on Monday, July 26, 1937, were read, and on a motion by Mr. C. A. Quail, seconded by Mr. E. S. Vieira, were confirmed.

FIXING THE PRICE OF HONEY.

Referring to the minutes, Mr. Henriques asked what action was being taken in regard to the fixing of honey prices. The general opinion was that the most expedient step was to appoint a standing committee, as the Director of Agriculture had previously suggested, to report on what action should be taken from time to time. After some discussion it was agreed that the President, the three Vice-Presidents with Mr. Henriques and Mr. Huggins be appointed to form the Committee.

ELECTION OF OFFICE-BEARERS.

On a motion moved by Mr. Henriques and seconded by Mr. J. G. Martin, the following members were elected to the Executive Committee for 1938 :—

His Excellency the Governor	....	Patron
Mr. E. A. Borman	....	President

Mr. W. M. A. Roberts	....	Vice-President
Mr. C. A. Quail	....	Vice-President
Mr. S. A. King	....	Vice-President
Mr. R. B. Hunter Mr. D. A. Hoo Mr. A. M. Fulton	....	Members of Committee
Director of Agriculture	....	Ex-officio Member
Mr. H. D. Huggins	....	Secretary-Treasurer

On behalf of those elected the President thanked the members and gave the assurance that an effort would be made to maintain the useful services of the Association during the year that was ahead.

HIS EXCELLENCY THE GOVERNOR TO BE ASKED TO BE PATRON.

It was decided that His Excellency the Governor, Sir Wilfrid Jackson, K.C.M.G., should be asked to become Patron of the Association, which honour his predecessors had been pleased to confer on the Association.

SECRETARY'S REPORT.

The Secretary's Report was then read.

Referring to the report, Mr. Henriques suggested that more advertising should be undertaken.

The Director of Agriculture drew attention to the considerable variation in honey crops. He pointed out that both consumption and production had gone up and that, if beekeepers wanted to be assured that production would at all times keep pace with demand, the supply of nectar plants should be increased. He was pleased to see lady members present and he hoped the indication was that interest in the movement was spreading. He was of opinion that village organisations might, with advantage, make beekeeping discussions with practical demonstration one of the phases of their activities. He mentioned that although the demand was not great there were at intervals enquiries for section honey.

Mr. D. A. Hoo drew attention to the fact that the Department had encouraged the distribution of honey plants by offering special prizes.

Mr. Dowding reminded members that the value of bees could not be estimated only from honey sales but the great service they did in regard to pollination and setting of fruit was important.

Mr. Borman mentioned that the village movement idea was an excellent one and he was already playing his part, since, on more than one occasion, he had given short talks to village organisations.

The Director of Agriculture suggested that a permanent advertising display, say in a grocery, was worth considering.

Mr. Hoo moved the adoption of the report and Mr. Vieira seconded.

Honey Display at the Berbice County Agricultural Exhibition.

The next item considered was the exhibition to be held in Berbice. After some discussion it was agreed that the Executive Committee should meet to discuss the space available and type of exhibit to be prepared for display at the forthcoming County Agricultural Exhibition to be held in Berbice.

The Director of Agriculture suggested that it might be arranged at some future meeting to have one or two papers presented by some of the more experienced beekeepers. Mr. Iloo agreed that this would be a good idea and was of opinion that his brother Mr. P. A. Iloo, would be willing to contribute one. Other names suggested were Mr. E. A. Borman, Mr. R. B. Hunter, Mr. L. D. Cleare and Mr. H. W. B. Moore.

The view was also expressed that it would be a pity if at ordinary meetings members, especially younger members, should refrain from expressing their opinions on subjects raised for discussion.

More than one member stated that beekeepers on the whole would be glad if it were possible for more beekeeping extension work to be done by the Department of Agriculture. There were many beginners for whom helpful attention was desirable.

Mr. Henriques suggested that the Association might approach Government with the object of obtaining a loan for the purpose of establishing the industry on a more extensive basis.

In regard to extension work, the Director of Agriculture mentioned that during the week of the County Agricultural Exhibition, Mr. Huggins would be in Berbice and it could probably be arranged for him to discuss their difficulties with the Berbice beekeepers.

The President read his report. He was thanked for his excellent summary of the year's activities and achievements, and the Director of Agriculture moved that the report be placed on record. Mr. C. A. Quail seconded.

Appreciation was expressed by the President and others for the interest taken by Mr. R. Williams of Rosehall, Corentyne, Berbice, and Mr. D. M. Khan of West Coast, Berbice, in being present that afternoon.

At this stage Mr. Henriques proposed Messrs. Z. D'Andrade and L. G. Smith as members.

The Chairman then thanked members for attending and the meeting came to a close.

NEWS.

A meeting of the Board of Agriculture was held on January 4 mainly to discuss the plaintain export trade and the Cattle Branding Ordinance.

The British Guiana Beekeepers' Association held its Annual General Meeting on January 24. Minutes of this meeting are published elsewhere in this Journal.

The Director and the Deputy Director, accompanied by the Agricultural Superintendent of the District, visited the experimental banana plot at Middlesex and the Toevlugt Farm Unit on January 13. The Deputy Director visited these trials on several occasions during the period under review. The Plant Pathologist visited the banana plot on January 11 and began spraying operations with Bordeaux mixture as a control against Leaf Spot and Panama Diseases.

The Deputy Director also visited Essequibo: East Coast, Demerara and Berbice.

The Director of Agriculture and the Hon. C R. Jacob left the Colony on January 29 for Surinam on a special mission to make a study of the situation in regard to the coffee industry and the recently organised Surinam Central Coffee Board.

On the Director's return on February 5 he proceeded to Trinidad to represent British Guiana at the Conference of the British West Indian Fruit and Vegetable Council held from February 9 to 15. During the Director's absence Capt. F. Burnett, Deputy Director, was appointed to act.

Mr. C. C Dowding, Agricultural Instructor, resumed duty after leave of absence on December 8.

The Secretary of State for the Colonies has been pleased to approve of the appointment of Mr. C. H. B. Williams, M.A., A.I.C.T.A., Dip. Agr., Cane Agronomist, to the post of Sugar Agronomist and Plant Breeder as from January 1, 1938.

Consequent on the appointment of Mr. E. M. Morgan as Assistant Agricultural Superintendent, Mr. H. A. Cole, Agricultural Instructor, has been promoted to the Senior Grade.

Mr. I. Dewar has been appointed to act as an Agricultural Instructor from February 1.

A Conference of the District Staff and Headquarters Officers concerned was held on January 20 and 21 and was presided over by the Deputy Director; the various programmes of district work and experiments to be carried out during 1938 were discussed.

Livestock importations by the Department during recent months have included:

Cattle. (Immunised against tick-borne diseases)

5 bulls and 3 heifers (Red Poll)
2 bulls and 3 heifers (Hereford)

Pigs.

2 gilts and 1 boar (Canadian Berkshire)

Poultry.

2 cockerels and 8 pullets (Barred Rocks)

Among recent visitors to the Department were the Hon. E. J. Waddington, C.M.G., Colonial Secretary; Prof. F. Hardy and Messrs. B. N. Ray and O. F. Churaman, from the Imperial College of Tropical Agriculture: Mr. J. J. Ochse, from Surinam; Monsieur Montayne, Dutch Consul General in New York; Mr. A. Wanford, of the Employers' Liability Assurance Corporation, Ltd., London; Mr. W. D. Lambie, His Majesty's Trade Commissioner for the West Indies; Mr. M. B. Palmer, Canadian Government Trade Commissioner and Mr. Edward J. King, M.C., Secretary of the British Empire Producers' Organization.

His Majesty the King has been pleased to appoint the Honourable E. J. Waddington, C.M.G., to be Governor of Barbados. Mr. Waddington, who was Colonial Secretary of this Colony since September 20, 1935, has always evinced the keenest interest in matters connected with the agricultural progress of the Colony.

As we go to press, news has been received that the Hon. G. D. Owen, C.M.G., Colonial Secretary of Barbados, has been appointed Colonial Secretary of British Guiana *vice* Mr. Waddington. Mr. Owen has formerly served in British Guiana from February 13, 1925 to September 3, 1931.

PLANT AND SEED IMPORTATION.

Introductions by the Department of Agriculture for the period November, 1937—February, 1938.

Name	Quantity.	Whence Supplied
Economic.		
Derris elliptica	cuttings	Puerto Rico Agrl. Expt. Stn., Mayaguez, Puerto Rico.
Tephrosia toxicaria	seed	do.
Cracca (Tephrosia) vogelii	seed	do.
Tree Tomato—*Cyphomandra betacea*	1 oz	East African Agrl. Research Stn., Amani, Tanganyika.
Tobacco Seed—Gold Dollar Strain 8	2 oz.	Coker Pedigreed Seed Co., Hartsville, S.C.
Lentils—Types 11 and 47, Hybrid III—86.	1 oz each	Botanical Sub Station, Imp. Dept of Agriculture in India, Pusa.
Peas—S. 29 and A-15	do.	do.
Assorted Vegetable Seeds	20 lb	Messrs. P. Henderson & Co., New York.
Ornamental.		
Flower Seeds—Assorted	182 pkts.	do
Roses—Double White Killarney	2 plants	do.
Roses 5 varieties	8 plants	Messrs. H. G. Hastings, U.S.A.
Roses 16 varieties	24 plants	Messrs. Benjamin R. Cant & Sons, Colchester, England.
Araucaria excelsa	1 plant	Messrs. G. Reuthe, Ltd., Keston, Kent, England
Lonicera Hildebrandiana	1 plant	do.
Thuya orientalis	1 plant	do.
Dendrocalamus strictus	2 plants	Puerto Rico Agrl. Expt. Stn., Mayaguez, Puerto Rico.
Beaumontia grandiflora	2 plants	do.
Gliricidia sepium	10 cuttings	do.
Phaeomeria speciosa	1 plant	do.
Vanilla planifolia	2 cuttings	do.

METEOROLOGICAL DATA, 1937.

BOTANIC GARDENS, GEORGETOWN.

1937 MONTHS	Rainfall, Inches	Number of Days of Rain: Under .10 in.	.10 in. to .50 in.	.50 in. to 1.00 in.	1.00 in. to 2.00 in.	Above 2.00 in.	Total Days	Evaporation, Inches
January	11.41	5	8	2	2	2	19	4.01
February	.95	9	2	...	...	...	11	5.08
March	1.26	9	6	...	...	...	15	5.88
April	5.44	3	10	1	1	...	15	5.51
May	12.43	4	10	8	4	...	26	4.23
June	17.80	7	9	5	6	1	28	3.76
July	15.63	3	12	5	2	2	24	3.88
August	7.22	3	12	3	1	...	19	4.60
September	3.16	3	3	...	...	1	7	5.69
October	3.10	1	5	1	1	...	8	5.44
November	4.10	1	4	3	1	...	9	4.76
December	9.66	6	6	3	2	1	18	3.12
TOTALS	92.16	54	87	31	20	7	199	55.96

AIR TEMPERATURE AND HUMIDITY IN THE SHADE.

BOTANIC GARDENS, GEORGETOWN.

MONTHS	Air Temperature: Maximum	Minimum	Mean	Humidity Mean
January	83.6	76.0	79.8	84.7
February	84.5	75.7	80.1	77.9
March	85.0	76.5	80.7	77.2
April	85.5	76 3	80.9	78.8
May	84.5	76.9	80.7	83.9
June	84.9	75.6	80.2	85.7
July	84.8	75.1	79.9	84.7
August	86.1	75.8	80.9	83.5
September	88.2	76.4	82.3	79.8
October	88.9	76.5	82.7	79.6
November	84.3	76.7	80.5	81.5
December	86.1	76.2	81.1	82.2
Mean	85.5	76.1	80.8	81.6

WETTEST AND HOTTEST DAYS AT VARIOUS STATIONS.

Stations	Wettest Days	Rainfall, Inches	Hottest Days	Temperature in shade °F
Botanic Gardens, Georgetown	June 19th	3.14	Sept. 9th	92.5
New Amsterdam, Public Gardens	July 25th	3.48	Sept. 8th & Oct. 23rd	94.0
Onderneeming Industrial School, Essequibo	Jan. 6th	3.60	Dec. 8th	93.0
Hosororo, N.W.D.	Dec. 24th	3.38	Sept. 9th	94.0

CURRENT PRICES OF COLONIAL PRODUCE

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XXI, No. 2, Tuesday, 28th February, 1938.

SUGAR.

Per 100 lb. net 3 lb. per Bag allowed for tare

Dark Crystals for Local Consumption..........$3.30
Yellow Crystals do. do. $4.00
White Crystals..........$4.75
Molasses Sugar... ....none offering.

Above Prices include Excise Tax of 90c.

RUM.

Imperial Gallon. Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export)...60c.; Hhds. 52c., Barrels 77c
White, in Hogsheads—40 to 45 O.P...(for local consumption)..........45 to 55c

MOLASSES.

Per Imperial Gallon. Naked.

Yellow (firsts)..........10c.
Yellow (seconds)..........5½c.

RICE.

Rice.........per Bag of 180 lb. gross. Brown Super $3.80 to $4.00 ; No. 1, $3.60—$3.75 ; White, None available. Lower Grades $2.75—$3.00 as to quality
Padi..........per Bag of 143 lb. gross, $1.00 to $1.50 as to quality.

GENERAL.

Gold, Raw,..........average per oz. $26 to $27.
Diamonds,—pro rata as to quality..........average per carat $10 to $11.
Timber, Greenheart, (Lower grade measurements)...40c. to 60c. per c. ft.; for export 72c. to $1.00 per c. ft.
do. Railroad Sleepers—(Mora) ....$1.68 each.
Greenheart Lumber..........$70 to $80 per 1,000 feet.
Crabwood Lumber..........$60 to $75 per 1,000 feet.
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,..........$4.50 to $6.00 per M.
Charcoal, Capped for shipment..........72c. to 85c. per bag.
Firewood..........$2.50 per ton.
Coconuts...Selects, $9.00, culls $6.00 per M...Copra $1.75 per 100 lb. prime Copra.
Balata..........Venezuelan, none. Local Sheet...36c. to 38c. per lb.
Cocoa..........19c. to 19½c. „ „
Coffee..........5c. to 5½c. „ „

N.B.—Duty Payable on value at time of Importation and rate of exchange on day of arrival.

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Agricultural Journal of British Guiana.

June, 1938.

EDITORIAL

THE RICE SITUATION.

Rice is the second most important agricultural industry of this Country. The frequent standard of estimating the importance of the crop in relation to the other industries is the value of exports. This may lead to an underestimation of the worth of this crop since rice is the most important article in local diet; consumption is increasing, the figure at present being approximately 21,000 tons annually, compared with an average export of 19,000 tons during the last five years. These figures furnish a better means of appreciating the crop's real importance.

As rice is grown almost entirely by the small producer, the vicissitudes of its production and marketing affect a considerable part of the Colony's farming population.

In agriculture, as in other walks of life, a proverb often quoted is: "Man proposes, God disposes." Man has made many proposals for the betterment of the rice industry in recent years, but the latter half of the proverb has been too much for him. For a number of years, up to 1933, rice production expanded remarkably but early in 1934 there came a flood whose damage was only less than the ill-effects of the drought which followed and lasted for the rest of the year; the Colony's rice exports were halved.

In 1935-36, production was again low on account of unfavourable weather conditions. Further, rice prices declined steadily: for example, the average price per 180 lb. bag of "super" grade was $4.02 in 1934, $3.83 in 1935 and $3.39 in 1936. Rice is a relatively short-term crop (compared, for instance, with sugar) and the area under cultivation from crop to crop reacts sensitively to price changes. Hence, although prices rose in 1937—super rose to $3.85 per bag—production, while taking an upward turn, was still below the high level reached a few years previously.

The year 1938 broke with prospects for the rice producer distinctly promising; a fair crop had been harvested and prices for forward shipments were higher than they had been since 1934. Unfortunately, the first half of 1938 has been characterized by rains more continuous and more abnormal than those of any year for which records are kept—the year 1893 alone excepted. The effect has been to render milling difficult and in some instances to bring it to a standstill. Almost all of the rice produced in British Guiana is parboiled. Padi is soaked in water, steamed and then dried on concrete floors in the sun. If the interval between steaming and drying is unduly long, rice of poor quality results. It is at this stage—the drying stage—that milling operations have broken down within recent months, since intermittent showers have made it well-nigh impossible to obtain sufficient sun to dry padi thoroughly enough for milling. The significant result of this season's experiences has been the fixing of attention on the great necessity for improved drying facilities in the Colony's rice factory organisation. It is universally admitted that had factory equipment included mechanical driers not only would good quality rice have been available but the Caribbean markets would have absorbed a much larger part of our crop at an attractive price before Burmese shipments began to arrive in April-May. A feature of recent years has been the improvement in quality of padi through the more general use by farmers of pure line seed distributed by the Department of Agriculture; it is unfortunate that the advantages of this improvement are not fully enjoyed by growers on account of poor milling facilities. Out of evil may yet come good, if this season's misfortunes have succeeded in demonstrating the necessity for improved rice factory equipment in general and in drying facilities in particular.

In regard to the Market outlook it is not easy to make a forecast for the latter part of 1938. The area sown in Burma in 1937-38 was the largest since 1933-34. India is the leading importing country but production this season is, with one exception, the largest since 1931-32. On the whole, therefore, imports into India from Burma are likely to be relatively small. It is not possible to gauge accurately what will be the imports into China since the far eastern hostilities must assuredly have far-reaching effects on the rice growing and consuming areas. Production in the Japanese Empire has this year attained a record and is in excess of the population's requirements; in addition, stocks at the beginning of the season were large. Imports are therefore not likely to be drawn upon. In British Malaya, relatively low rainfall led to expectations of a short crop but the setback in the rubber situation is considered likely to affect rice imports. The situation in Ceylon indicates that no great change is likely to take place in regard to imports. Production in Java has been rising in recent years so that not only have domestic supplies been met but exports have actually been made to the Outer Provinces. These circumstances indicate that Burmese shippers are likely to take steps to dispose of as much of their present crop in the Caribbean as that market can be induced to absorb.

ORIGINAL ARTICLES.

MALARIA IN BRITISH GUIANA.

PART I. THE ANOPHELINE MOSQUITOES OF THE COLONY.

BY

G. GIGLIOLI, M.D. (IT.), M.R.C.P., (LOND.); D.T M. & H. (ENG.).

Medical Adviser to the Sugar Estates of British Guiana.

The malaria problem, in all its phases, is intimately related to agriculture: malaria is eminently a rural disease and rural and agricultural populations suffer most from its ravages

Malaria is closely connected with the distribution of surface waters and land configuration; agriculture, by altering surface water conditions and land configuration, through drainage and irrigation, directly affects, beneficially or adversely, the incidence of malaria. Extensive agriculture often favours malaria; intensive agriculture, on the contrary, radically eliminates it. It is by the forcible establishment of intensive agriculture in localities recently reclaimed by drainage, where malaria had reigned supreme for ages, that such brilliant results have been reaped, in less than a decade, in the Pontine marshes and other classical malaria regions of central and southern Italy.

Agriculture, in this Colony, is eminently extensive in its type; sugar and rice: both these forms of cultivation are dependent on adequate irrigation; sea water is injurious and must be excluded, hence sea defences and elaborate systems of sluices and pumping stations; rain and flood waters are stored in conservancies situated aback of the cultivation, to feed thousands of miles of irrigation canals which riddle the coastlands. Thus ideally favourable breeding sites are provided for mosquitoes, at all seasons, and breeding continues the year around with greater or lesser intensity, according to the temperature and the individual characteristics of each species.

In this Colony, perhaps more than elsewhere, the connection between agriculture and malaria is intimate: there can be no doubt that the prevailing forms of cultivation, rice and sugar cane, influence the malaria problem adversely.

Malaria is a *mosquito borne* disease; not all mosquitoes are capable of transmitting it; this pernicious role is exclusively restricted to mosquitoes of the genus *Anopheles*. These facts can now be regarded very nearly as common knowledge; but it is not, as yet, at all appreciated that the carrier problem must be restricted to yet a much more limited field: *only a relatively small number of species, in fact, out of the many included in the genus Anopheles have practical importance in the transmission of malaria.*

Some species of Anopheles are not susceptible to infection, even when repeatedly fed on patients harbouring abundant malaria parasites in their blood, in the phase suitable for mosquito infection. In others, infection occurs, but the parasite appears unable to undergo its full development and fails to reach the stage in which it again becomes infectious to man when inoculated in the blood stream through the mosquito's bite. Such species of Anopheles, evidently, are constitutionally unfit for the transmission of malaria and their practical importance to the malariologist is nil.

There are other species of Anopheles which in the laboratory can be infected with malaria with the greatest ease, but under natural conditions very rarely become infected as they bite *animals selectively* and man only as the exception. It is very unlikely that an individual mosquito, belonging to one of these "zoophylous species", should bite man repeatedly at the interval required for it to become infective. *Transmission of malaria by such species is evidently possible, but sufficiently unusual to lose much, if not all, practical importance.*

With some species *zoophylia* is a constant characteristic; in others it may be acquired under favourable conditions; thus a same species of Anopheles may be found to be a dangerous carrier in one region, whilst it is zoophylous, and therefore harmless, in others. Such is the case with the species *Anopheles maculipennis*, the main vector of malaria in Europe; with the advent of intensive agriculture, which implies an abundance of livestock and animal shelters, this species tends to restrict its biting activities to the shelter of stables, cowsheds and pig-sties; "biological varieties" evolve which do not attack man, and thus lose all importance as natural vectors of malaria.

In England, in the districts where malaria, in a not too distant past, used to be endemic, *A. maculipennis* still abounds, not in homes but in animal shelters. We have seen it in enormous numbers in Surrey pig-sties and cow barns. Likewise in Italy zoophylous biological varieties of this species exist at present in localities which were malarious only a few decades ago.

In the American tropics, some 30 or 40 species of Anopheles have been listed by various authorities. These species vary widely in their geographical distribution, their feeding and breeding habits and in their infectability to malaria.

We have outlined these facts as they constitute the basal principles on which rational malariology is founded.

In any given malarial locality the following are the first and basal problems to be resolved:

(1) The identification of the local existing species of Anopheles.

(2) The distribution and incidence of such species in relation to the distribution and incidence of malaria.

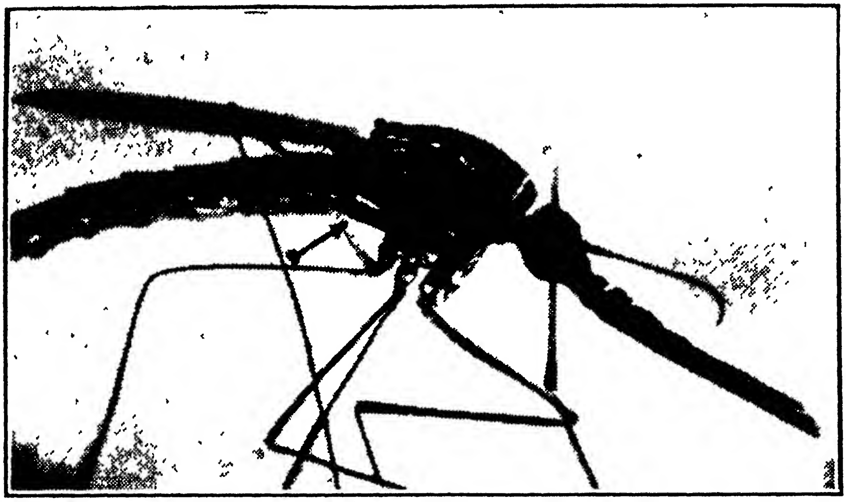

FIG. 1.—*Anopheles albitarsis:* Adult female. The two longitudinal parallel lines of large white scales which adorn the ventral aspect of the first abdominal segment (sternite) are distinctive of this species.

FIG. 2.—Wing markings of:
(a) *A. albitarsis.*
(b) *A. darlingi.*

(3) The detailed biology of each species with special regard to breeding, biting and flying habits.

Once these data are fully acquired we have at our disposal the means for intelligent, direct and, above all, economical malaria prevention : our whole effort can be concentrated on the *control of the species which is or are the proven vectors of malaria in the region* ; the others may be ignored in all safety.

The conditions we have found in this Colony are a very striking example of this definite limitation of the malaria problem to a single Anopheline species. The practical importance of this fact is too obvious to be stressed : it means that for the control of malaria in British Guiana we must deal with a *single species*, subject to certain definite limitations in its breeding habits ; we can, on the other hand, ignore other species of Anopheles, much less exacting, as we shall see, in their breeding requirements. In consequence of their greater adaptability these latter species are very much more widely distributed and abundant so that, given the physical configuration and climate of the colony, their control would be practically impossible.

The whole classification of tropical American Anophelines is, at present, under revision as methods have been perfected greatly of late years ; the anatomical characters of the males have acquired great taxonomic importance.

It is by no means possible, at present, to give a complete catalogue of the local species of Anophelines ; we can only mention those which we have encountered in our personal experience of some 15 years. From 1934 to the time of writing we have examined and identified over 20,000 specimens collected from numerous coastal localities between the Essequebo and Corentyne estuaries and from the interior, on the Demerara, Essequebo and Potaro rivers. We are indebted to Mr. and Mrs. H. E. Turner for a collection of 70 Anopheles captured in various localities on the Rupununi Savannahs in August 1936.

Three species of Anopheles are widely distributed and very abundant in the Colony. They all belong to the sub-genus *Nyssorhynchus* the members of which can easily be recognized by the silvery white extremities of their hind legs. We will not go into detailed descriptions, limiting our exposition strictly to the main differential characters which are of practical importance in the field and in the laboratory for routine identification purposes. The more important of these characters are very plainly visible in our series of micro-photographs.

A. tarsimaculatus. This species can easily be identified with the help of a simple magnifying glass, as it possesses a black spot or ring at the base of the last segment of the hind legs. It is ubiquitous : we have specimens captured in houses in Georgetown, from West and East Demerara, from Western Berbice and the Corentyne coast, where we have found it particularly abundant. It is occasionally found along the rivers in the interior, wherever some clearing of the forest has been effected. This species is also represented in our collection from the Rupununi.

We have also observed the occurrence of a known variety of *A. tarsimaculatus* characterized by having a larger portion of the hind legs white; (the black portion of the 2nd tarsal segment is represented by only a narrow ring at its base). We have specimens of this variety from the Berbice Estuary and from the Rupununi Savannahs.

The existence of *A. tarsimaculatus* in the Colony has long been known. Bodkin and Cleare observed that it abounded in localities which were only mildly malarial. It has been regarded as the principal carrier of the disease on the coast. Flu and more recently Bonne and Bonne Wepster expressed the same opinion as regards the coastland of Surinam.

In our own experience, though the larvæ of this species are by far the most commonly and easily found, *A. tarsimaculatus* is relatively rarely caught in the dimly lighted native houses: but it is not at all uncommon to capture it in bright, electrically lighted estate hospitals or staff houses. It is evidently attracted there by the light as myriads of other winged insects. *A. tarsimaculatus* becomes active at dusk; but occasionally and in proximity of its breeding sites, it may attack in large numbers and in full sunlight when disturbed from its resting places in high grass or bushes. It can be found at all seasons, throughout the year, but is much more abundant during the warmer months from May to October.

A. tarsimaculatus abounds in stables, cattle and sheep pens, and can easily be caught on horses and cattle in the open, after sunset. With Mr. Komp, of the United States Public Health Service, in July 1936, we observed this species in countless thousands in cattle sheds at Gibraltar, on the Corentyne coast, some 10 miles east of New Amsterdam. This locality is practically free from malaria. The sheds were open to the strong sea breeze and the Anopheles were crowded over the timber sills forming the base of the building, some 6 inches off the ground; many were actually resting on the rough, damp clay floor evidently resisting the strong breeze with considerable difficulty. Males were also present in large numbers, this fact indicating the close proximity of their breeding sites in the extensive frontland brackish marshes. *A. tarsimaculatus* haunts savannal countries open to sun and wind: it is a hardy species and its resistance to the desiccating action of the wind is very considerable.

This species shows remarkable adaptability and latitude in the choice of its breeding sites: irrigation canals, drainage trenches, flood fallowing cane fields, rice fields, flooded pastures and savannahs, swamps, marshes, ponds, rain water collections of all kinds, puddles, cow holes, ruts, clean water and dirty water, salt, brackish and rain water, strongly acid, neutral and alkaline water, all suit it and in all it flourishes. Brackish waters are probably its favourite breeding sites, hence its abundance in the extensive salt marshes of the Corentyne coast frontlands. The pH of waters in which *A. tarsimaculatus* was found breeding ranged from 4 to 7.8; the sodium chloride contents from g. 0.005 to g. 28.000 per litre.

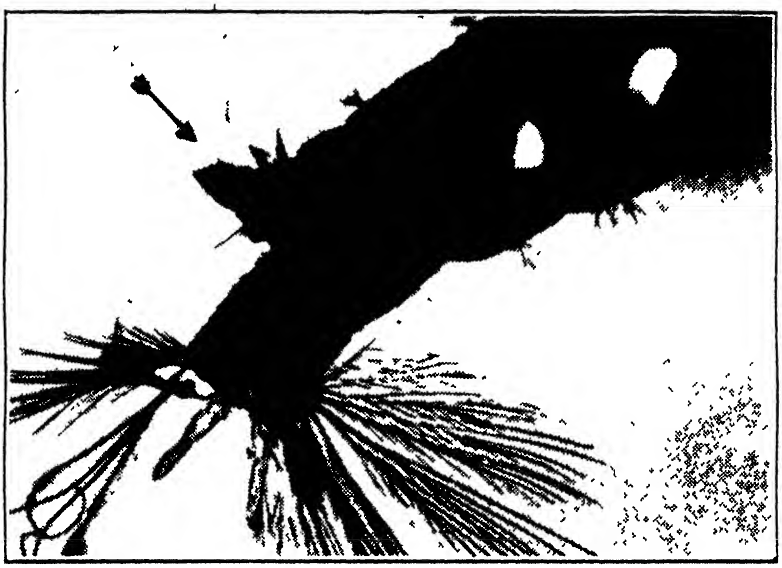

FIG. 3.—Caudal portion of the larva of *A. darlingi* showing the two characteristic bristles which surmount the dorsal plate of the spiracular or respiratory mechanism. This feature is peculiar to this species.

FIG. 4.—Pupae of:
(a) *A. albitarsis* (note scoop-shaped breathing trumpets).
(b & c) *A. darlingi* (the margins of the breathing trumpets are deeply indented).

The two following species, *A. albitarsis* and *A. darlingi*, though extremely common, have not previously been identified in this Colony, being in the past regarded as a single kind under the erroneous designation of *A. argyritarsis*. This confusion is easily explained by the close similarity among the adults of the *Nyssorhyncus* group; on the other hand, the differential characters which are revealed by closer examination are so evident and distinctive that it is surprising they should have eluded detection for so long.

A. argyritarsis is a valid species first described in Panama; its importance as a malarial vector was there regarded as of small moment. It occurs in Brazil, but, up to recently, even in that country, it was currently and widely confused with the following two species.

Exact information on its geographical distribution is still lacking: so far we have failed to find it in this Colony. This, evidently, does not exclude definitely its presence, but we feel authorized to state that even if it does occur in small numbers; or in restricted foci, the importance of this species, in relation to the malarial problem in British Guiana, is nil.

A. albitarsis: the adult insects of both sexes can be easily recognized by the presence of two parallel rows of conspicuous white scales on the ventral surface of the 1st abdominal segment (*1st sternite*). In dried specimens, through retraction, the sternite is usually concave so that these lines of scales acquire a V—like or converging disposition. Fig. I shows the latero-ventral aspect of a female *A. albitarsis*, one of the rows of scales we have described is clearly visible.

Fig. II demonstrates the differences in the wing markings of *A. albitarsis* and *A. darlingi*: the different disposition of white and black markings of the the costa, or anterior wing rib, at its base, should be noted: in the former (a) two small black spots stand out in contrast on the white background; in the latter (b) the colour scheme is reversed and two small light coloured spots stand out on a black background. The light coloured wing scales of *A. albitarsis* are white; those of *A. darlingi* are golden yellow.

The larvæ of *A. tarsimaculatus* and *A. albitarsis* though very similar, can be differentiated in the laboratory on the characters of some of their ornamental hairs, but for this purpose a certain amount of experience is necessary. The pupæ of these species vary considerably in colour, from dark to light brown, yellowish or bright green; we know of no good character for their differentiation.

The distribution of *A. albitarsis* in the Colony is wide; we have collected it in West and East Demerara, in Western Berbice and on the Corentyne coast; we have never observed it in the forest areas of the interior and we doubt its existence in such districts. Ninety per cent. of our specimens from the Rupununi belong to this species.

A. albitarsis presents a well marked seasonal incidence: it appears early in May and continues throughout the warmer weather to October or November,

fluctuations occurring from year to year according to variations in the seasonal distribution of the rainfall. It is very unusual to find this species between December and April.

The favourite haunts of *A. albitarsis* are open savannahs and pastures where cattle abound. It occurs in great numbers on the backdams of Western Berbice estates and on the Abary savannahs. It naturally flies and feeds after dusk, but if disturbed from its shelter in the grass or bushes it will attack viciously and in full sunlight. Riding on the Abary savannahs and, we understand, in the Rupununi, is often made very unpleasant by the attentions of this mosquito. It is little affected by high breezes and, on the whole, we have found it a much hardier species than the following one.

In the selection of its breeding sites it appears to favour large bodies of water well exposed to the sun : flooded savannahs and pastures ; flood fallowing canefields ; ricefields ; irrigation canals, etc. It also occurs occasionally in ponds, small drains and temporary rain water collections.

The waters in which it breeds are clean, slightly acid or neutral in reaction, with a low content in soluble salts (pH range 6.6 to 6.9 ; sodium chloride 18 to 30 milligr. per litre).

A. darlingi : the adult insects of both sexes in this species present the following differential characters : the distal half of the 2nd and all of the 3rd, 4th and 5th tarsal segments of the hind legs are snow white ; the wing markings are distinctive, and there are no white scales on the 1st abdominal sternite. These characters have already been described when dealing with *A. albitarsis* and are well illustrated in Figs. I and II.

The larva of *A. darlingi* presents a very striking and unique character in the form of two long, straight bristles, surmounting papillæ placed on the dorsal plate of the spiracular or breathing mechanism. These bristles are directed dorsally so that when the larva lies horizontally just below the water surface, they protrude through the surface film ; they are very clearly shown in Fig. III and can be detected already in the 2nd and 3rd stage of larval development.

The pupa of *A. darlingi* is equally well characterized ; its colour is always dark brown ; the breathing trumpets which in *A. tarsimaculatus* and *A. albitarsis* are delicately chitinized with a plain scoop-like shape, in *A. darlingi* have a very much more elaborate structure : the trumpets are heavily chitinized, more open and present on their lateral margins deep indentations which give rise to two very characteristic finger-like projections. Our micro-photographs illustrate these characters more effectively than any description (Figs. IV, V, and VI).

A. darlingi was first described by Root at Bahia, Brazil, in 1926 : the investigations of Shannon, Davis, Kumm, Benarroch and others have demonstrated its wide distribution in equatorial South America. It ranges from the foot hills of the Andes throughout the Amazon valley to the Atlantic seaboard ; it occurs in Venezuela and we have established its presence in British Guiana ; its southern range is not, as yet, fully determined.

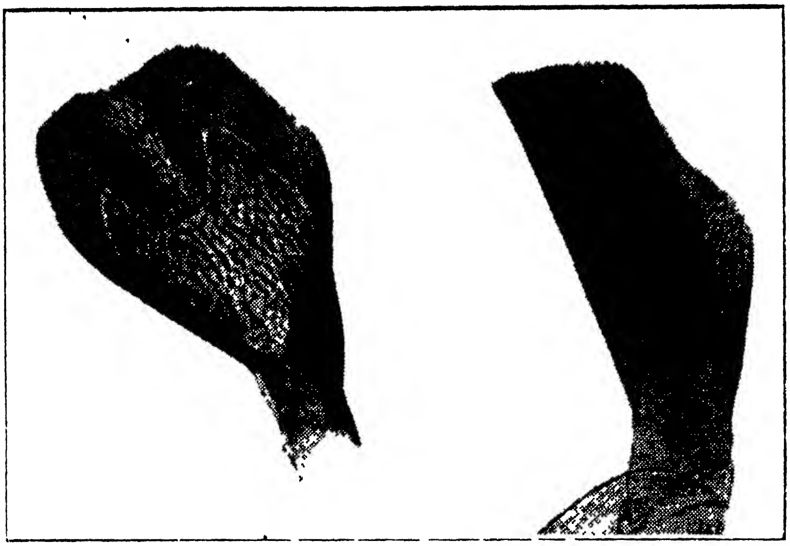

FIG. 5.—Breathing trumpets of *A. albitarsis.*

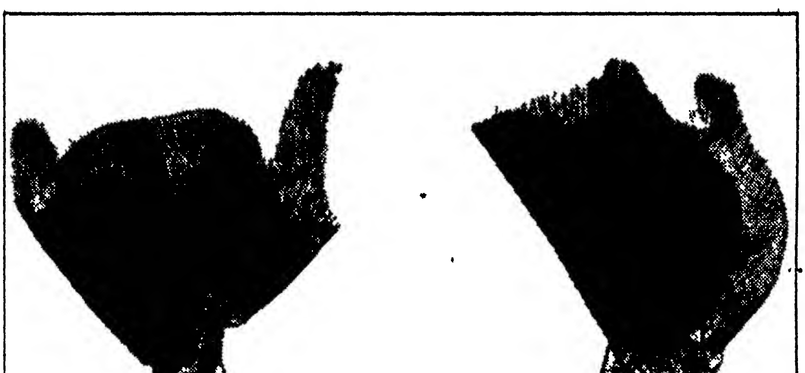

FIG. 6.—Breathing trumpets of *A. darlingi.*

In the Colony it is *the* Anopheles of the forest areas of the interior on the tidal and flood rivers; we have collected it in large numbers on the mid and upper Demerara, on the Essequebo and Potaro Rivers. On the coast it is often associated with *A. tarsimaculatus* and *A. albitarsis* but its general distribution does not follow these two species. In some coastal localities it is extremely abundant, particularly on the estuaries of the Demerara and Berbice rivers and on the West and East Coast of Demerara. So far we have had difficulty in finding it at Cane Grove and it is definitely rare along the sea coast of Western Berbice. It represented only 8.3% on 697 Anopheles captured in houses on Bath Estate between 1934 and 1937. This species occurs also in our Rupununi collection: a single specimen was captured on human bait in a partly forested district at the foot of the Kanuku Mountains.

The three species we have described, *A. tarsimaculatus*, *A. albitarsis*, and *A. darlingi*, between them, account for 99.9% of the 20,000 adult *Anopheles* we have collected and identified. All the larvae and pupae we have examined, without exception, belong to these three species.

Other Anophelines, evidently, occur in the colony but always in small numbers and it is quite exceptional to capture them in houses. We have some female specimens of two different species belonging to the *Arribalzagia* group; they were all caught in wooded localities, on the the mid-Demerara, on the Berbice Estuary and in the Rupununi District, most of them on animal bait in the open; larvae and males have not, as yet, been found and for this reason their exact identification is still doubtful.

A. (Stethomyia) nimbus has been reported from the Colony and Komp found it common in the forest at Kartabo in July 1936.

It is quite evident that these and eventually other rare, or at least uncommon, species, can have no practical importance from a malariological standpoint. Malaria in British Guiana is extremely prevalent and widely distributed; its carrier or carriers must therefore, evidently, be equally common.

We have seen that *A. tarsimaculatus*, *A. albitarsis* and *A. darlingi* are all extremely numerous with a wide range of distribution, all of them, therefore in this respect could adequately fill the role of malaria carriers.

The relative importance of each one of these species in regard to the transmission of malaria, under local conditions, will next be treated.

(To be Continued)

RESULTS OF PADI VARIETAL TRIALS AND EXTENSION WORK, 1937.

BY

F. BURNETT, M.C., M.A.,
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During the Autumn Crop of 1937, fourteen variety trials were laid down, six standard trials containing the same varieties for trial at various centres in the Colony, and eight trials with promising varieties. The sites of these experiments were as follows:—

Berbice :	Whim. No. 63.	Under the supervision of Mr. J. D. Gillespie, Agricultural Superintendent.
Demerara :	Georgetown Rice Station.	Under the supervision of Mr. E. M. Peterkin, Agricultural Superintendent.
	Hope, East Bank.	Under the supervision of Mr. H. D. Huggins, Agricultural Superintendent.
	Vreed-en-Hoop.	Under the supervision of Mr. A. A. Abraham, Agricultural Superintendent.
Essequibo :	Henrietta. Leguan. Wakenaam.	Under the supervision of Mr. E. G. Benson, Agricultural Superintendent.

The results are presented in Tables I and II.

TABLE I.

STANDARD TRIALS.

Site.	Vreed-en-Hoop.		Leguan		Wakenaam.		Whim.		W.C., Berbice.		No. 63.	
Layout.	8 × 8 Latin Square.		8 × 8 Latin Square		8 × 8 Latin Square.		8 × 8 Latin Square.		8 Randomised Blocks.		8 Randomised Blocks.	
Variety.	Padi per acre. lb.	Order of Merit.	Padi per acre. lb.	Order of Merit.	Padi per acre. lb	Order of Merit.	Padi per acre. lb.	Order of Merit.	Padi per acre. lb.	Order of Merit.	Padi per acre. lb.	Order of Merit.
D114	3330	2	4375	4	4165	1	4835	4	2435	1	4665	1
D110	3070	4	4635	1	4040	3	4895	3	2045	6	4385	4
D99	3475	1	4135	6	4093	2	4010	8	2230	2	4535	2
Kalyaman	2660	8	4535	2	3893	5	5095	1	1950	7	4205	7
D.C.	3090	3	4108	7	3365	8	4958	2	2125	4	4495	3
No. 79	2665	7	4463	3	4008	4	4605	7	2125	4	4255	5
D109	2995	5	3848	8	3708	6	4640	6	2140	3	4075	8
D91	2895	6	4140	5	3460	7	4705	5	1862	8	4215	6
Significant Difference, P=.05	374		291		235		321		...		344	

TABLE II.

PADI TRIALS—NEW VARIETIES.

Site.	George town (No. 1).	Site.	George-town (No. 2)	Site	George-town (No. 3).	Site.	George-town (No. 4)	Site.	George-town (No. 5).	Site.	East Bank, Demerara.	Site.	Henrietta (No 1)	Site.	Henrietta (No. 2).
Layout.	10 × 10 Latin Square	Lay-out.	8 × 8 Latin Square.	Lay-out.	8 × 8 Latin Square	Lay-out.	7 × 7 Latin Square.	Layout	7 × 7 Latin Square	Layout.	6 × 6 Latin Square.	Layout.	8 × 8 Latin Square.	Layout.	8 × 8. Latin Square.
Variety.	Padi per acre, lb.	Vari-ety.	Padi per acre. lb.	Vari-ety.	Padi per acre. lb.	Vari-ety	Padi per acre. lb.	Variety.	Padi per acre. lb.	Variety	Padi per acre. lb.	Variety.	Padi per acre lb.	Variety.	Padi per acre. lb.
D114	3588	D99	3840	D115	2695	D114	3680	D115	3029	D114	2897	D114	3900	D114	3648
D221	3252	D92	3300	D221	2550	B1	3109	D99	2737	D.C.	2746	D99	3858	D110	3505
D97 (B)	3228	D116	3290	D109	2460	D C.	3063	D C	2623	D109	2617	D109	3680	D109	3415
D.C	3192	D110	3120	D89	2425	B3	2811	D97 (B)	2583	Kalyaman	2210	No. 79	3530	D89	3320
D109	3164	D88	3070	D C.	2320	No. 79	2726	Kalyaman	2440	No. 79	1423	D91	3413	No. 79	3080
D91	3160	D90	2865	D92	2320	B6	2674	No. 79	2263	D99	1274	Blue Stick	3345	Blue Stick	3035
No. 79	3092	D.C	2745	D110	2280	B4	2640	D90	2290			D.C.	3320	D.C.	2970
D88	2984	No. 7	2690	No. 79	2165							Kalyaman	3260	D88	2895
Kalyaman	2960														
D228	2752														
Significant Difference P = .05	400		324		...		193		286		698		183		179

The following conclusions may be drawn from Table I. :—

(a) *Vreed-en-Hoop*. *D99* is significantly superior to all other varieties except *D114*, which surpasses the rest except *Demerara Creole*, *D109* and *D110*.

(b) *Leguan*. There is no significant difference between *D110*, *Kalyaman*, *No. 79* and *D114*, but the first three are significantly superior to the other four varieties tested.

(c) *Wakenaam*. Again the first four varieties *D114*, *D99*, *D110*, and *No. 79* are equal to one another. The other varieties tested are all inferior to these with the exception of *Kalyaman*, which is surpassed only by *D114*.

(d) *Whim*. There is again equality among the first four varieties *Kalyaman*, *Demerara Creole*, *D110* and *D114* of which *Kalyaman* alone surpasses the rest. *D99* is significantly inferior to all the others.

(e) *No. 63, Berbice*. Equality again exists between the first four varieties *D114*, *D99*, *Kalyaman*, and *D110*, of which *D114* alone surpasses the rest. *D109* is surpassed also by *D99* and *Kalyaman*.

The following conclusions may be drawn from Table II. :—

(a) *Georgetown* (*Experiment No. 1*). *D114* was superior to all the other varieties tested except *D221*, *D97* (*B*) and *Demerara Creole*.

(b) *Georgetown* (*Experiment No. 2*). *D99* far outyielded the other varieties tested. *Demerara Creole* and *No. 79* were disappointing.

(c) *Georgetown* (*Experiment No. 4*). *D114* was outstandingly superior. *B1* and *Demerara Creole* were bracketed second, while the other four varieties were significantly inferior.

(d) *Georgetown* (*Experiment No. 5*). *D115* was superior to all the other varieties, *No. 79* again disappointed.

(e) *East Bank, Demerara*. *D114*, *Demerara Creole* and *D109* were bracketed first, of which *D114* was significantly superior to the rest.

(f) *Henrietta* (*Experiment No. 1*). *D114* was superior to the other varieties tested except *D99*, which in turn surpassed the rest except *D109*.

(g) *Henrietta* (*Experiment No. 2*). *D114* was again superior to the other varieties tested except *D110*, which in turn surpassed the rest except *D109*.

SUMMARY OF ALL TRIALS.

A general comparison between all the varieties tested during 1937 is shown in Table III, which is shown graphically. The average yields per acre of the varieties are calculated as percentages of the *Demerara Creole* yield which is taken as the standard.

TABLE III.
Summary of 1937 Variety Trials.

Variety	No. of Trials.	Average Yield per acre Compared with Demerara Creole. (100.0)
D114	11	117.1
D110	9	110.2
D99	10	106.1
D91	9	103.7
D109	11	103.6
Kalyaman	10	103.0
D116	1	102.1
Blue Stick	2	99.0
No. 79	14	97.3
B1	1	96.5
D88	3	92.6
D97 (B)	2	90.2
D221	2	90.0
D89	2	89.1
D90	1	88.9
D115	2	88.6
D92	2	87.2
B3	1	87.2
D228	1	85.4
B6	1	83.0
B4	1	81.9

BLUE STICK STRAIN TRIAL.

Four strains of the *Blue Stick* variety were selected and tried out in a trial in 1936. This experiment was repeated in 1937, and the results are shown in Table IV. As in 1936, no significant difference was revealed between the yields of the various strains, and it is concluded that the *Blue Stick* grown on the Henrietta Station is pure, so that no further advantage can be gained by selection within the variety.

TABLE IV.

Site	Henrietta
Layout	5 × 5 Latin Square
Strain	Padi per acre, lb.
Ordinary *Blue Stick*	2808
Strain 4	2760
Strain 2	2692
Strain 1	2612
Strain 3	2552
Significant Difference P = .05	...

LONG GRAIN TRIAL.

Four long-grained rices were received at the Henrietta Station in 1937, and they were put in a trial to see how they compared with the ordinary *Blue Stick* cultivated on the Essequibo Coast. The results of the trial shown in Table V reveal no significant difference between any of the varieties.

TABLE V.

Site	Henrietta
Layout	5 × 5 Latin Square
Ordinary *Blue Stick*	4020
Seymour Padi	3768
Jaisingh Padi	3760
Ramjess Padi	3560
Sue's Padi	3520
Significant Difference P = .05	...

VARIETAL NOTES.

The following is a summary of the past performances of some of the more important varieties :—

Demerara Creole. In 1930 this variety came third in the Essequibo and Berbice trials, fifth in the Demerara trial. In 1931 it came third in the Demerara, fifth in the Essequibo trial. In 1932 was fifth in the Demerara, third in the Essequibo trial. In 1933 was fourth and fifth in the Demerara trials, fourth in Essequibo. In 1934 it was fifth in two Demerara trials, seventh in Essequibo. In 1935 it was extensively tried in ten trials, and could surpass *No. 79* only four times. In 1936, in twelve trials, it was beaten by *No. 79* ten times, and in eight trials with *Blue Stick* was beaten six times. 1937 selections improved on the 1936 performance and outyielded *No. 79* in nine trials out of fourteen.

No. 79. In 1930 this variety outyielded all varieties in two trials, and came second in another. First place was again taken in two trials in 1931. In 1932 this performance was repeated, and in 1933 again it proved superior in three trials. In 1934 it came second in two trials, but made eighth place in another. In 1935 it gained two firsts and three seconds in ten trials, followed this up in 1936 by surpassing *Demerara Creole* ten times in twelve trials. In 1937 it unaccountably failed, and its performance was very poor, being surpassed by *Demerara Creole* nine times in fourteen trials.

Blue Stick. This variety did well in one trial in 1930. Tried twice in 1931 it was second in Essequibo but sixth in Demerara. Tried only once in 1932, it came second in Essequibo. It jumped up to a consistent second place in each of three trials in 1933, and repeated this good performance in 1934 by coming first in Demerara and second in Essequibo. In 1935 its yields were only average, but it did extremely well in 1936, when it surpassed *Demerara Creole* six times out of eight, and *No. 79* six times out of ten. In 1937 it was tried only twice, at Essequibo, and came sixth each time.

D. 114. This variety made its début in 1934, and came second in its one trial. In 1935, placed in six trials, it outyielded *Demerara Creole* every time, *Blue Stick* four times and held its own with *No. 79.* It put up a wonderful performance in 1936, gaining four first places, three seconds, and two thirds in thirteen trials, and in 1937 this was even bettered when it came first in eight trials out of eleven, being beaten by *Demerara Creole* and *No. 79* only once.

D. 110. This variety first appeared in a trial in 1935, when it was fourth, yielding higher than *Demerara Creole*, *No. 79* and *Blue Stick.* In 1936 it was placed in eight trials and surpassed *Demerara Creole* every time and *No. 79* four times. In 1937, appearing in nine trials, it surpassed *No. 79* eight times, and *Demerara Creole* three times.

D. 99. Like *D. 110*, this variety came out in 1935. In three trials it came first twice. Appearing in only two trials in 1936, it was first in both. This splendid performance was continued in 1937, when in ten trials, it gained two firsts and five seconds, surpassing *Demerara Creole* and *No. 79* seven times each ; only the outstanding *D. 114* could give better yields than this variety during this year.

MISCELLANEOUS TRIALS.

A trial was carried out at Henrietta in which transplanting seedlings of different ages was tested out. The results of this trial are shown in Table VI.

TABLE VI.

Site	Henrietta
Layout	5 × 5 Latin Square
Age of Seedlings	Padi per acre lb.
3 weeks old	4072
4 ,, ,,	4008
5 ,, ,,	3904
Double Transplanting	3800
6 weeks old	3704
Significant Difference P = .05	188

The following conclusions may be drawn :—

(a) There is no significant difference between seedlings transplanted 3, 4, or 5 weeks old.

(b) Double transplanting and transplanting seedlings 6 weeks old are both inferior to seedlings transplanted 3 weeks and 4 weeks old.

(c) Transplanting seedlings 5 weeks old is not superior to double transplanting, but is superior to transplanting seedlings 6 weeks old.

The results of this experiment agree with those obtained in 1935, both showing no significant differences between transplanting seedlings 3, 4, or 5 weeks old, with, however, a trend in favour of the younger seedlings. The results of 1936 are in conflict with these two results. A further trial may give some definite answer to this problem.

Table VII presents the results obtained with planting different numbers of seedlings per hole.

TABLE VII.

Site	Henrietta
Layout	5 × 5 Latin Square
Number of Seedlings per hole	Padi per acre lb.
7	2800
5	2696
3	2460
2	2436
1	2388
Significant Difference P = .05	194

There is no significant difference between the yields obtained from 7 and 5 seedlings per hole. Both, however, give significantly higher yields than 3, 2 or 1 seedlings per hole. These results are in direct contrast with those of 1936, in which experiment fewer seedlings per hole were significantly superior to greater seedlings per hole. Further investigations must be carried out to obtain definite information.

PURITY OF PADI CULTIVATIONS.

During the 1937 Autumn Crop the usual estimations of purity of padi cultivations were carried out in the various districts. These estimations are shown in tabular form in Table VIII. In each district can be seen at a glance the total acreage under rice cultivation, and the areas of pure line and purities of approximately 90%, 90%—75%, 75%—50%, and under 50%. These areas are calculated in percentages of the total acreage, and from these figures are derived the percentage area of a district which shows purities greater than 75% and 50% respectively.

Information regarding the area of seed farms supplying each district is also given.

TABLE VIII.

DISTRICT.		Total.	Pure L.ne.	Purity Approx. 90%.	Purity Approx. 90—75%.	Purity Approx. 75—50%.	Purity below 50%.	Total Purity greater than 75%.	Total Purity > 50%	Seed Farms.
Berbice	Acreage	27755	3985	10914½	7792¼	3424	1639	22692	26116	933
	% Total Area	100	14.7	39.3	28.1	12.3	5.9	82.1	94.4	3.4
East Demerara	Acreage	15350	1331	3916	5635	3291	1177	10882	14173	181
	% Total Area	100	8.7	25.5	36.7	21.4	7.6	70.9	92.3	...
East Bank, Demerara	Acreage	342	3	3	115	221	0	121	342	0
	% Total Area	100	.87	.87	33.6	64.6	0	35.3	100	0
West Demerara	Acreage	5352	3375	1094	167	393	323	4636	5029	101¾
	% Total Area	100	63.1	20.4	3.1	7.3	6.0	86.6	93.9	1.9
Essequibo	Acreage	6118¾	10	244½	976	2547¼	2340¾	1230½	3778	244½
	% Total Area	100	1.6	4.0	15.9	41.6	38.3	21.5	63.1	4.0
Wakenaam	Acreage	3014	740	1102	869	273	30	2711	2984	112
	% Total Area	100	24.5	36.6	28.8	9.1	1.0	89.9	99.0	3.7
Leguan	Acreage	2378	387	719	959	308	5	2065	2373	57
	% Total Area	100	16.3	30.2	40.3	13.0	0.2	86.8	99.8	2.4

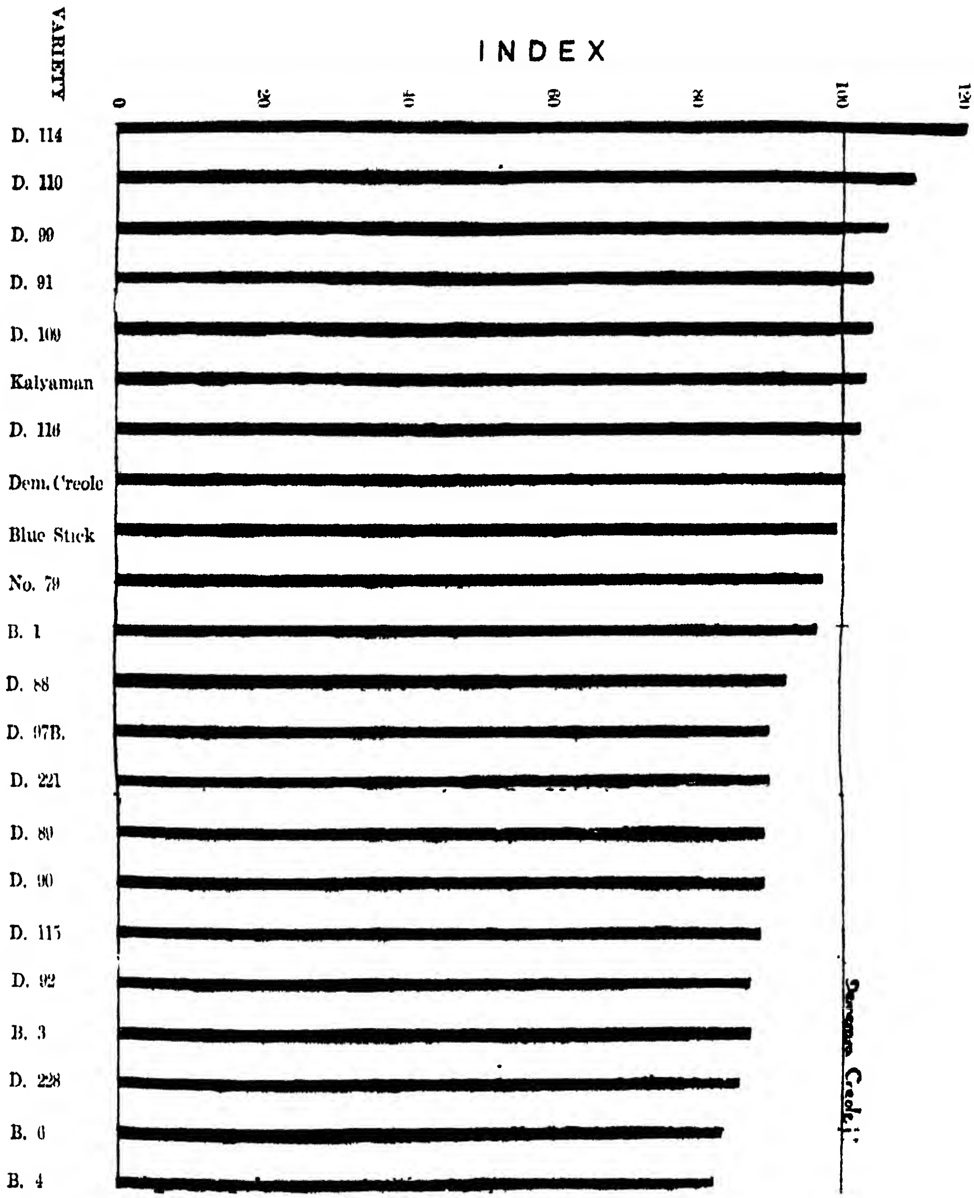
PROGENY ROWS.

1. GEORGETOWN EXPERIMENT STATION.

At the end of the 1937 Autumn Crop some of the varieties were not considered worthy of being kept any longer in the progeny rows. These padis were under observation for several seasons, and their characters proved to be of little value. The following is a list of the varieties which were discarded :—

DISCARDED VARIETIES.

Variety.	Date Received.	Origin.	Reasons for Discarding.	No of Seasons Tested.
H6	No record	No record	Poor yield	7
No. 77	" "	" "	" "	6
No. 78	" "	" "	" "	7
Garikasannavari	Sept. 1928	Madras, India	Poor yield, short grain	7
Kristna Kata Kulu	" "	" "	Poor yield, short grain	7
Peru	4.12.29	Peru	Poor yield, awned grain	7
Sago	30.9.31	Berbice	Small grain	8
Sonacalif	30 3.33	Fiji Islands	Poor yield	6
Louisiana	18 7 33	Louisiana	" "	6
Ok Shot	17.10.33	Mandalay	Poor yield, small grain	5
Theik Pan	"	"	Poor yield, small grain	5
Jajai	27.10.33	Larkana, Sind	Poor yield, very thin grain	5
Prong 36	"	"	Poor yield, small grain	4
Basmati	7 11 33	Punjab, India	Poor yield, very thin grain	6
Mushkan 7	"	"	Poor yield, very thin grain	5
Magoi	"	"	Poor yield, small grain	6
Kataktara	10.1 34	Assam, India	Poor yield	4
D 154	13 1 34	Bombay	Poor yield, small grain	4
D 157	3.2.34	Tanganyika	Poor yield	4
D 158	"	"	" "	5
D 173	19 3.34	Central Provinces, India	Poor yield	4
D 175	"	"	Poor yield, small grain	4
D 181	"	United Provinces, India	Poor yield	4
D 190	16 4.34	Tanganyika	Poor yield, thin grain	4
D 191	"	"	Poor yield, thin grain	4
D 195	"	"	Poor yield	4
Orealla	29.8.34	Orealla, Corentyne	" "	4
Oerang-Oerangan	30.8.34	Java	Poor yield	3
Paloe Alessoe	"	"	Poor yield, awned grain	3
Maoemi	"	"	Poor yield	3
D 230	10 11.34	Sind, India	Poor yield, thin grain	4
D 235	"	" "	Poor yield, thin grain	4
D 237	19.11.34	North Borneo	Poor yield, small grain	4
B 2	1931	Hybrid of D C. x Americano 1600	Poor yield	3
B 8	"	"	" "	4
C 1	"	Hybrid of Mexican Edith x D.C.	" "	3



Comparison between yields of varieties tested and Demerara Creole.

The following list comprises the total number of varieties which are now being tested at the Georgetown Experiment Station. The table shows the varieties, with places of origin and dates received, the number of seasons they have been tried, their average yields per thousand plants over these seasons, and their grain characteristics, whether long, medium, or short.

VARIETIES UNDER TEST AT GEORGETOWN EXPERIMENT STATION.

Variety.	Date received.	Origin.	No. of seasons tested	Yield per 1,000 plants, lb.	Type of Grain.
Demerara Creole	No record	No record	7	61.1	Long
Blue Stick	"	"	6	62.6	Medium
McKenzie Large	"	"	7	63.2	"
McKenzie Small	"	"	7	70.7	Short
H7. ...	"	"	6	61.2	Medium-long
No. 75	"	Probably India	7	54.7	"
No. 76	"	Local selection	7	56.9	Long
No. 79	"	"	7	61 6	Medium
Ramcajara	"	"	7	61 4	Medium, broad
Ak Kulu	Sept. 1928	Madras, India	7	74.7	Short
A16. 34	Oct. 1928	Burma	7	56.0	Medium-long
C14. 31	"	"	7	67.1	Short, broad
Toledo District	17.11.28	British Honduras	8	25.0	Medium, broad.
Lead Rice	11.12.29	Mr. Abdool Rayman	7	61.4	Short, broad.
No. 36	28.1.30	Trinidad	7	59.4	Medium, broad.
No. 11	"	"	6	74.5	Short, broad.
Kalyaman	"	"	7	54.0	Long.
Rupununi	1931	Rupununi	8	25 6	Medium, broad.
White Pin	30.9.31	Berbice	7	22.4	" "
Minalabon	11.4.32	Philippine Islands	5	62.5	Medium
D 88	12.10 33	Local selection. W.C. Demerara.	5	63.7	Medium, Long.
D 89	"	"	5	71.9	Long.
D 90	"	"	5	77.9	"
D 91	"	"	5	63.6	"
D 92	"	"	5	70.6	Medium-long.
D 94	"	"	5	69.6	Medium.
D 95	"	"	5	53.6	"
D 97 A	1.10.33	Local selection. Expt. Station	5	61.2	"
D 97 B	"	"	3	69.7	"
D 99	"	"	4	70.9	"
D 100	"	"	4	61.2	Medium-long.
Karimganj	17.10.33	Mandalay	5	84.8	Short
D 108	18.10.33	Local selection. W.C. Demerara.	5	78.9	Medium
D 109	"	"	5	73.4	Medium-long
D 110	"	"	5	68.5	Medium.
D 114	"	"	5	68.9	Medium-long.
D 115	"	"	5	86.3	"

Variety	Date received.	Origin.	No. of seasons tested.	Yield per 1000 plants, lb.	Type of Grain.
D 116	18.10.33	Local selection, W.C. Demerara	5	73 6	Medium-long
Unity	9.11.33	Unity, E.C. Dem.	5	88.3	Medium
D 135	10.1.34	Assam, India	4	54.8	Short
D 150	"	"	4	57.3	Short
D 156	3.2.34	Tanganyika	5	58.5	Medium-long
D 160	"	"	4	59.2	"
D 162	28.2.34	Bengal, India	4	69.4	Medium
D 176	19.3.34	Central Provinces, India	4	63.5	"
D 183	16.4.34	Madras, India	4	74 8	Short
D 184	"	"	4	51 0	"
D 188	"	"	4	57.9	"
D 193	"	Tanganyika	4	69 1	Medium
D 205	17.5.34	North Borneo	4	53.0	"
Kao Bang Pra	17 7.34	Siam	4	37.7	"
D 221	13.9.34	Local selection. Berbice	4	67 6	Long
D 222	"	"	4	53.9	Medium-long
D 224	"	"	4	67.2	Medium
D 225	"	"	4	57.2	"
D 228	2.10.34	"	4	63.7	Long
D 236	19 11.34	North Borneo	4	47.8	Short, broad
D 238	"	"	4	62 0	Medium
D 239	27.11.34	Local selection, Essequibo	3	81.7	"
D 242	3.11.34	Local selection, W.C. Berbice	3	56.1	Medium-long
D 243	"	"	3	59.8	Medium
D 244	27.11.34	Local selection, Essequibo	3	78.2	Short
D 245	Novr. 1934	Local selection, Berbice	3	59.5	Medium
D 246	7.10.35	Local selection. Expt. Station.	2	71 6	Medium.
D 247	"	"	2	81.3	"
D 248	10.10.35	Surinam	2	31.3	Medium-long.
D 249	"	"	2	13.4	Medium
D 250	9.10.35	Local selection, Wakenaam.	2	73.9	"
D 251	"	"	2	70.5	Medium-long
D 253	15.10.35	Local selection, Leguan.	2	84.2	"
D 254	"	"	2	85.6	"
D 255	25.10.35	Local selection, Vreed-en-Hoop.	2	110.2	Medium-long.
D 256	"	"	2	92.9	Medium.
D 257	"	"	2	106.2	"
D 258	"	"	2	82.2	"
D 259	"	"	2	85.1	Long.
D 260	4.12.35	Local selection, W.C. Berbice.	2	38.4	Medium.
D 261	"	"	2	54.1	"
D 262	"	"	2	45.5	"
D 263	"	Local selection, Skeldon.	2	37.2	"
D 264	"	Local selection, Skeldon.	2	35.7	Medium-long.
D 266	8 3.36	Sierra Leone	1	46.4	Short.
D 267	"	"	1	4.5	"
D 268	"	"	1	25.0	"
D 297	Novr. 1937	Local selection, Expt. Station.	...	...	Long.
Padi, B'ce.	1935	Local selection, Berbice.	2	100.7	Medium-long.

Variety.	Date received.	Origin.	No. of seasons tested.	Yield per 1000 plants, lb.	Type of Grain.
Nickerie Patna	1935	Local selection, Berbice	2	75.4	Medium-long
Seymour S.	1936	Mr. Seymour	1	76.8	Long
No. 1—37	1931	Hybrid—D.C. x Americano 1600	4	72.1	Short
„ 3—37	„	„	3	60 7	Short
„ 4—37	„	„	3	64 5	„
„ 5—37	„	„	4	62.3	Medium
„ 7—37	„	„	3	65.9	„
„ 8—37	„	„	4	72.7	„
„ 9—37	„	„	3	72.1	Short
„ 11—37	„	Hybrid-Mexican Edith x D.C.	4	61.6	Medium-long
„ 12—37	„	Hybrid-Kristna Kata Kulu x No 79	2	71.1	Medium
„ 13—37	„	„	2	80.6	Long
„ 14—37	„	„	2	69.4	Medium
„ 15—37	„	„	2	82.4	„
„ 16—37	„	„	2	75.9	„
„ 17—37	„	„	2	89.8	„
„ 18—37	„	„	2	73.1	„
„ 19—37	„	„	2	82 6	„
„ 20—37	„	„	2	70.3	„
„ 21—37	„	„	2	56.1	„
„ 22—37	„	„	2	64 8	„
„ 23—37	„	„	2	75 7	„
„ 24—37	„	„	2	47 9	Medium long
„ 25—37	„	„	2	52 5	Long
„ 26—37	„	„	2	56.5	Medium-long
„ 27—37	„	„	2	57.1	Long
„ 28—37	„	„	2	68.1	Medium-long
„ 29—37	„	„	2	72 1	Medium-long
„ 30—37	„	„	2	65.1	Long
„ 31—37	„	„	2	67.5	Medium-long
„ 32—37	Novr. 1937	Local selection, Expt. Stn. G'town.	...	...	Medium
„ 33—37	„	„	...	...	„
„ 34—37	„	„	...	...	„
„ 35—37	„	„	...	...	„
„ 36—37	„	„	...	...	„
„ 37—37	„	„	...	...	Medium-long
„ 38—37	„	„	...	...	„
„ 39—37	„	„	...	...	„
„ 40—37	„	„	...	...	„
„ 41—37	„	„	...	...	Long
„ 41—37	„	„	...	...	Medium-long
„ 42—37	„	„	...	...	„
„ 43—37	„	„	...	...	Long
„ 44—37	„	„	...	...	„
„ 45—37	„	„	...	...	„
„ 46—37	„	„	...	...	„
„ 47—37	„	„	...	...	„
„ 48—37	„	„	...	...	„
„ 49—37	„	Local selection, Expt. Station, Henrietta.	...	...	Medium-long
„ 50—37	„	„	...	...	„
„ 51—37	„	„	...	...	Long
„ 52—37	„	„	...	...	„
„ 53—37	„	„	...	...	„

Variety	Date received.	Origin.	No. of seasons tested.	Yield per 1000 plants, lb.	Type of Grain.
No. 54—37	Nov. 1937	Local selection, Expt. Station, Henrietta,	...	...	Long.
„ 55—37	„	„	...	...	Medium-long.
„ 56—37	„	„	...	...	„
„ 57—37	„	„	...	...	„
„ 58—37	„	„	...	...	„
„ 59—37	„	„	...	...	„
„ 60—37	„	„	..	...	„
„ 61—37	„	„	...	...	„
„ 62—37	„	„	...	...	„
„ 63—37	„	„	...	...	Long.
„ 64—37	„	„	...	...	„
„ 65—37	„	„	...	...	Medium-long.
„ 66—37	„	„	...	...	Long.
„ 67—37	„	„	...	...	Medium-long.
„ 68—37	„	„	...	...	Long.
„ 69—37	„	„	...	...	„

2. Henrietta Experiment Station.

Blue Stick Variety.—Selections of this variety made from the 1936 Autumn Crop were established in progeny rows during the 1937 Spring Crop. Four strains selected from these were put in a Strain trial (see page 86) with the ordinary *Blue Stick*, but results showed no significant difference in yield. Progeny Rows were still maintained in the 1937 Autumn Crop, and now there are under test twelve selections of this variety.

Local long grains. Because of the demand in Essequibo for long-grained types of padi, selection work was begun in the 1937 Spring Crop. Progeny rows of various padis were established, and now there are under test the following :—

Varieties Under Test at Henrietta Experiment Station.

Variety.	Date received.	Origin.	No. of seasons tested.	Type of Grain.
L1	1936	Affiance	2	Long.
L2	„	Aberdeen	2	„
L3	„	Spring Garden	2	Medium-long.
L4	„	Wakenaam	2	„
L5	1937	Hampton Court	—	...
L6	„	Johanna Cecilia	—	...
L7	„	L'Union	—	...

Indian Padi. During the 1937 Autumn Crop progeny rows were established of a sample of padi received from Messrs. Seymour and Sayse Narayan, who imported it from India. The sample was very mixed, and before planting was arbitrarily divided into classes based on grain lengths. Selections were further made at the end of the crop, so that now there are 26 selections of this padi under test.

PROGRAMME OF WORK FOR 1938.

1. Variety Trials.

Fourteen variety trials will be laid down in 1938 in selected sites of the Colony. These are as follows :—

The first six trials will be carried out at Georgetown, Henrietta and Whim.

A. Standard Long Grain Trials.

I. 5 Randomised Blocks.

1. Padi Berbice
2. D251
3. D253
4. D254
5. D259
6. Jaisingh
7. Demerara Creole
8. Kalyaman

L. G. Controls. (7–8)

9. D114
10. D99

M. G. Controls. (9–10)

II. 5 Randomised Blocks.

1. D221
2. Nickerie Patna
3. Seymour S.
4. No. 13-37
5. No. 29-37
6. D91
7. Demerara Creole
8. Kalyaman

L. G. Controls. (7–8)

9. D114
10. D99

M. G. Controls. (9–10)

B. Standard Medium Grain Controls.

III. 5 Randomised Blocks.

1. D94
2. D108
3. Unity
4. D162
5. D193
6. D109
7. Demerara Creole
8. D221

L. G. Controls. (7–8)

9. D114
10. D99

M. G. Controls. (9–10)

IV. 5 Randomised Blocks.

1. D258
2. D261
3. D262
4. No. 15-37
5. No. 16-37
6. D110
7. Demerara Creole
8. D221

L. G. Controls. (7–8)

9. D114
10. D99

M. G. Controls. (9–10)

V. 5 Ramdomised Blocks.

1. D246
2. D247
3. D250
4. D255
5. D256
6. D257
7. D116
8. Demerara Creole } L. G. Controls.
9. D221
10. D114 } M. G. Controls
11. D99

VI. 5 Randomised Blocks.

1. No. 17-37
2. No. 18-37
3. No. 19-37
4. No. 23-37
5. Blue Stick.
6. D115
7. Demerara Creole } L. G. Controls.
8. D221
9. D114 } M. G. Controls.
10. D99

The remaining trials are individual district trials and are distributed in the various localities mentioned.

C. INDIVIDUAL DISTRICT TRIALS.

VII. No. 63 (Shied Trial)
5 Randomised Blocks.

1. Demerara Creole
2. No. 79
3. D99
4. D114
5. D115
6. D116
7. Babylon No. 1
8. Benab No. 1
9. D97 (B)
10. Benab No. 79

IX. W. C. Berbice (site to be selected).
5 Randomised Blocks.

1. D114
2. Demerara Creole
3. Kalyaman
4. D99
5. No. 79
6. D116
7. D110
8. D115
9. D221

VIII. W.C. Berbice (site to be selected).
5 Randomised Blocks.

1. Demerara Creole.
2. No. 79
3. D99
4. D114
5. D115
6. D116
7. Babylon No. 1
8. Benab No. 1
9. D97 (B)
10. Benab No. 79.

X. Henrietta. Long Grain

XI. Trials with D114 as control. To be drawn up after results of Spring Crop.

XII. Georgetown. Long Grain

XIII. Trials With D114 as control: To be drawn up after results of Spring Crop.

XIV. Vreed-en-Hoop
5 Randomised Blocks.
1. D114 (control)
2. D99
3. D110
4. Kalyaman
5. Demerara Creole
6. D115
7. D116
8. Seymour S.
9. Jaisingh

2. MISCELLANEOUS TRIALS.

The trials to determine (1) the optimum age for transplanting seedlings (2) the optimum number of seedlings per hole have not as yet given any conclusive results. These trials will be continued at Henrietta during the 1938 Autumn crop.

3. DEMONSTRATIONS.

In the districts certain varieties are being grown for demonstration purposes. These demonstrations can be seen in the named localities.

District.	Site.	Variety.	Area.
W.C. Berbice	To be selected	D114	5 acres
	Abary District	No. 79	2 ,,
East Demerara	Novar.	No 79 and D 99	
	Glazier's Lust	No. 79	80 ,,
	Cove & John	D114	5 ,,
East Bank, Demerara.	To be selected.	D114	1½ ,,
		No. 79	1½ ,,
West Demerara.	La Grange.	D114	3 ,,
	Fellowship.	D114	3 ,,
	Vreed-en-Hoop.	D114 & D.C.	5 ,,

Manurial experiments are also being planned in conjunction with the Chemist and will be laid down both at the Georgetown and Henrietta Experiment Stations.

THE VARIETY AND FERTILISER POSITION OF THE SUGAR INDUSTRY, IV.

BY

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ESTATE YIELDS IN 1937.

The Department of Agriculture is again indebted to the Managers of the Colony's sugar estates for kindly supplying statistics of the commercial yields secured during 1937. The data are condensed and presented in Table I. In Table II are given the weighted mean yields of the three principal varieties for the past four years.

The outstanding conclusion to be drawn is the marked superiority of P.O.J. 2878 to its nearest rival, Diamond 10, on frontland soils. Large acreages of both canes have now been reaped, as plants, first and second ratoons, in several seasons and throughout the sugar belt, and it is clear that P.O.J. 2878 may be expected to yield, for a cycle of three crops, over a ton of sugar per acre more than Diamond 10. The latter is, however, a decided improvement on D. 625. On the pegasse soils, the differences are less marked, but P.O.J. 2878 continues to head the list. "Mixed" areas, S.C. 12/4 and B.H. 10/12 should be eliminated.

TABLE I.

WEIGHTED MEAN YIELDS OF 96° SUGAR PER ENGLISH ACRE FROM THE MAJOR VARIETIES GROWN IN BRITISH GUIANA DURING 1937.

		Frontland Soils.						Pegasse Soils.				
		P.O.J. 2878	Diamond 10	D 625	Mixed	S.C. 12/4	B.H. 10/12	P.O.J. 2878	Diamond 10	D 625	Mixed	S.C. 12/4
Plant Canes	Acres reaped :	4,906.5	6,908.7	2,176.8	152.9	3[illegible]5.0	67.1	1,810.3	1,780.7	343.7		--
	Yield of sugar/acre, tons	3.81	3.42	3.[illegible]	2.94	2.83	3.40	3.34	3.29	2.92		—
First Ratoons	Acres reaped	2,227.2	5,8[illegible]9.1	4,908.1	986.6	249.2	54.2	991.6	1,359.9	667.6	194.5	22.1
	Yield of sugar/acre, tons	3.78	3.00	2.97	2.24	2.85	2.67	3.16	2.82	2.79	2.63	2.71
Second Ratoons	Acres reaped :	1,070.5	4,264.1	6,331.3	1,018.2	235.7	48.8	796.3	832.3	932.7	497.3	48.6
	Yield of sugar/acre, tons	3.61	3.23	2.62	2.26	2.62	2.36	2.63	2.44	3.12	2.01	1.67
Three Crops	Total Yield of sugar/acre, tons :	11.20	9.65	9.12	7.44	8.30	8.43	9.13	8.55	8.83	-	-

Table II.

WEIGHTED MEAN YIELDS OF 96° SUGAR PER ENGLISH ACRE FROM THE MAJOR VARIETIES GROWN IN BRITISH GUIANA DURING 1934-1937.

		Frontland Soils.			Pegasse Soils.		
		P.O.J.2878	Diamond 10	D. 625	P.O.J.2878	Diamond 10	D. 625
Plant Canes	Acres reaped :	8,707.4	22,050.8	24,654.5	3,480 2	3,110.1	2,525.4
	Yield of sugar per acre, tons :	3.94	3 55	3.38	3 25	3.43	3.51
First Ratoons	Acres reaped :	3,971.1	17,082.4	29,755.8	1,818.3	2,091.7	3,756 9
	Yield of sugar per acre, tons :	3 76	3 08	3.00	3.16	2.95	2.81
Second Ratoons	Acres reaped :	1,462.1	11,418.1	27,533.6	860 6	1,324.1	3,373.5
	Yield of sugar per acre, tons :	3.25	3 04	2.67	2.71	2.46	2.70
Three Crops	Total Yield of sugar per acre, tons .	10.95	9.67	9 05	9 12	8.84	9 02

VARIETAL COMPOSITION OF THE 1938 HARVESTS.

The estate Managers have also kindly furnished data from which it has been possible to prepare Tables III and IV and Figure I, showing the relative importance, by area, of the varieties to be harvested in 1938.

Table III.

PERCENTAGE DISTRIBUTION OF THE VARIETIES TO BE REAPED DURING 1938.

(*Varieties listed represent 100% of the total area to be harvested.*)

Variety.	Total English Acres in the Colony.	Percentage in West Demerara.	Percentage along Demerara River Banks.	Percentage in East Demerara.	Percentage in Berbice.
Diamond 10	26,356.08 (41.3%)	22.3	39.3	17.1	21.3
P.O.J. 2878	20,228.99 (31.7%)	13.5	6.8	32.6	47.1
D. 625	13,140.72 (20.6%)	...	2.6	34.9	62.5
Mixed	2,537.31 (4.0%)	16.8	44.5	0.1	38.6
S.C. 12/4	996.46 (1.6%)	48.3	43.1	1.2	7.4
Miscellaneous	324 33 (0.5%)	3.9	34.4	15.2	46.5
B.H. 10 (12)	170.08 (0.3%)	73.3	9.5	17.2	...
	63,753.97 (100.%)				

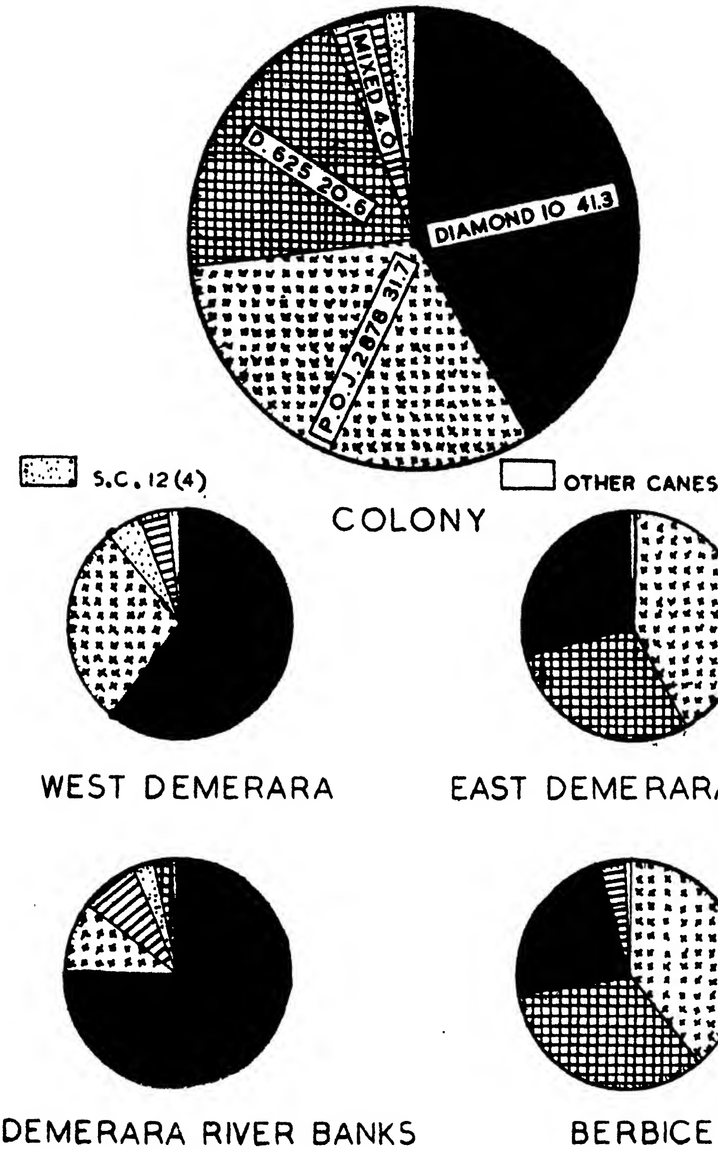

Fig. I.

Relative Varietal Composition of the Cane Areas to be harvested in British Guiana in 1938.

TABLE IV.

VARIETAL COMPOSITION OF THE CANE AREAS TO BE REAPED IN THE VARIOUS DISTRICTS IN 1938.

(Varieties listed represent 100.0% of the total area to be harvested.)

DISTRICT.	DIAMOND 10.		D. 625.		P.O.J. 2878.		MIXED.		S.C. 12/4.		Miscellaneous.		B.H. 10 (12).		TOTAL ENGLISH ACRES TO BE REAPED IN DISTRICT.
	English Acres.	Per cent. of Total Area to be Reaped in District.	English Acres.	Per cent. of Total Area to be Reaped in District.	English Acres.	Per cent. of Total Area to be Reaped in District.	English Acres.	Per cent. of Total Area to be Reaped in District.	English Acres.	Per cent. of Total Area to be Reaped in District.	English Acres.	Per cent. of Total Area to be Reaped in District.	English Acres.	Per cent. of Total Area to be Reaped in District.	
West Demerara:	5,883.94	60.9	...	...	2,727.08	28.3	426.18	4.4	481.01	5.0	12.62	0.1	124.72	1.3	9,655.55
Demerara River Banks:	10,346.13	75.3	335.43	2.5	1,374.13	10.0	1,130.34	8.2	429.10	3.1	111.73	0.8	16.19	0.1	13,743.05
East Demerara:	4,504.34	28.5	4,590.20	29.1	6,587.98	41.8	1.58	...	12.25	0.1	49.31	0.3	29.17	0.2	15,774.83
Berbice:	5,621.67	22.9	8,215.09	33.4	9,539.80	38.8	979.21	4.0	74.10	0.3	150.67	0.6	...	...	24,580.54
Colony:	**26,356.08**		**13,140.72**		**20,228.99**		**2,537.31**		**996.46**		**324.33**		**170.08**		**63,753.97**

The replacement of D. 625 by Diamond 10 and P.O.J. 2878 is progressing rapidly and only 21 per cent. of the acreage is now in the old favourite. On the other hand, P.O.J. 2878 is now expanding much more rapidly than Diamond 10 and will probably soon pass it. "Mixed" areas continue to drop. These points are brought out in Table V.

TABLE V.

COMPARISON OF AREAS OF D. 625, DIAMOND 10, P.O.J. 2878 AND "MIXED" IN THE COLONY DURING RECENT YEARS.

Variety.	Per Cent. of Total Area in the Colony.				
	1934	1935	1936	1937	1938
D. 625 ...	62.5	55.4	44.6	33.0	20.6
Diamond 10 ...	16.8	22.7	29.4	36.6	41.3
P.O.J. 2878 ...	1.4	4.7	9.7	19.2	31.7
"Mixed" ...	9.5	12.6	12.7	8.8	4.0

Diamond 10 and P.O.J. 2878 occupy 89 per cent. of the cane area in West Demerara and 85 per cent. on the Demerara River Banks, but in East Demerara and Berbice, D. 625 still covers 29 and 33 per cent., respectively, of the area to be harvested.

The item "miscellaneous" includes mainly new seedlings which are being tested commercially. More areas could, with advantage, be devoted to this purpose all over the Colony, but especially in West and East Demerara.

FERTILISERS IN 1937.

In Table VI, the fertiliser imports for 1937 are compared with those of recent years, the data being adapted from the Reports of the Comptroller of Customs.

TABLE VI.

FERTILISERS IMPORTED INTO BRITISH GUIANA IN RECENT YEARS.

Year.	Nitrogenous Fertilisers (almost entirely Sulphate of Ammonia).			Manurial Lime (including Limestone).			Other Fertilisers (mainly Superphosphate and Basic Slag with some Sulphate of Potash).			Total Imports.	
	Tons	Value $	Value per ton $	Tons	Value $	Value per ton $	Tons	Value $	Value per ton $	Tons	Value $
1926	6,691	403,407	60.29	2,806	32,952	11.74	2,072	42,100	20.32	11,569	478,459
1927	7,271	393.084	54 06	3.507	40.777	11 63	3,871	94,826	24.50	14,649	528,687
1928	6,721	359,526	53 49	3,766	41,290	10.96	2,277	47.139	20.70	12,764	447,955
1929	6,693	358,231	53.52	2,560	26,051	10.18	2,971	71,189	23.96	12,224	455,471
1930	7,207	316,158	43.87	2,754	27,394	9.95	2,624	62,069	23.65	12,585	405,621
1931	7.165	249.107	34 77	3,239	32,984	10.18	3,226	83,460	25.87	13,630	365,551
1932	8,294	254,726	30.71	4,366	42,071	9.64	2.619	54,281	20.73	15,279	351,078
1933	7.681	263,456	34 30	4.749	42.569	8 96	2,937	76,617	26 09	15,367	382,642
1934	7 727	248,185	32 12	4,306	38,524	8.95	2.168	48,735	22.48	14,201	335,444
1935.	10,268	333,732	32.50	4,917	39,521	8.04	3,096	60,812	19.64	18,281	434,065
1936	9.963	334,556	33.58	3.786	28,453	7 52	2,639*	52,092*	19.74	16.388	415.101
1937	11,171	367.689	32.91	4,537	33,342	7.35	2,537†	49,509†	19.51	18.245	450,540
Mean	8.071	323,488	40.08	3,774	35,494	9.40	2,753	61.902	22.49	14,598	420.884
% of Mean Annual Imports :	55·29	76.86		25.85	8.43		18.86	14.71			

*Includes 152 tons of Sulphate of Potash, valued at $6,652 or $43.76 per ton.
†Includes 160 " " " " " " $6,929 or $43.31 per ton.

Imports of sulphate of ammonia, which have shown a tendency to rise throughout the twelve-year period, reached a record of 11,171 tons in 1937. Its cost per ton has been climbing slightly since 1934. Imports of manurial lime (mainly pulverised limestone) were considerably higher than in 1936 and well above the twelve-year average; its cost is dropping. Slightly less "other fertilisers" were imported than in 1936 and the cost per ton was a few cents lower.

All the sulphate of ammonia came from the United Kingdom and all of the manurial lime from the British West Indies (Trinidad and, to a lesser extent, Barbados). Of the phosphates, 77 per cent. came from Belgium, most of the rest from Holland and a small quantity from Germany. The potassic manures came almost exclusively from Germany.

Of the money spent for fertilisers, some 77 per cent. goes for sulphate of ammonia, 15 per cent. for phosphates and potash, and 8 per cent. for limestone and lime.

More than 95 per cent. of the fertilisers imported are used on the sugar estates and much of the remainder by small cane farmers. The estates have kindly supplied details as to the various manures used in 1937 and the data are summarised in Tables VII and VIII and Figure II.

In 1937 the estates spent 79 per cent. of their fertiliser bill on sulphate of ammonia. The imports of lime have shown a further drop in favour of limestone which is easier to handle and cheaper.

PLATE V.

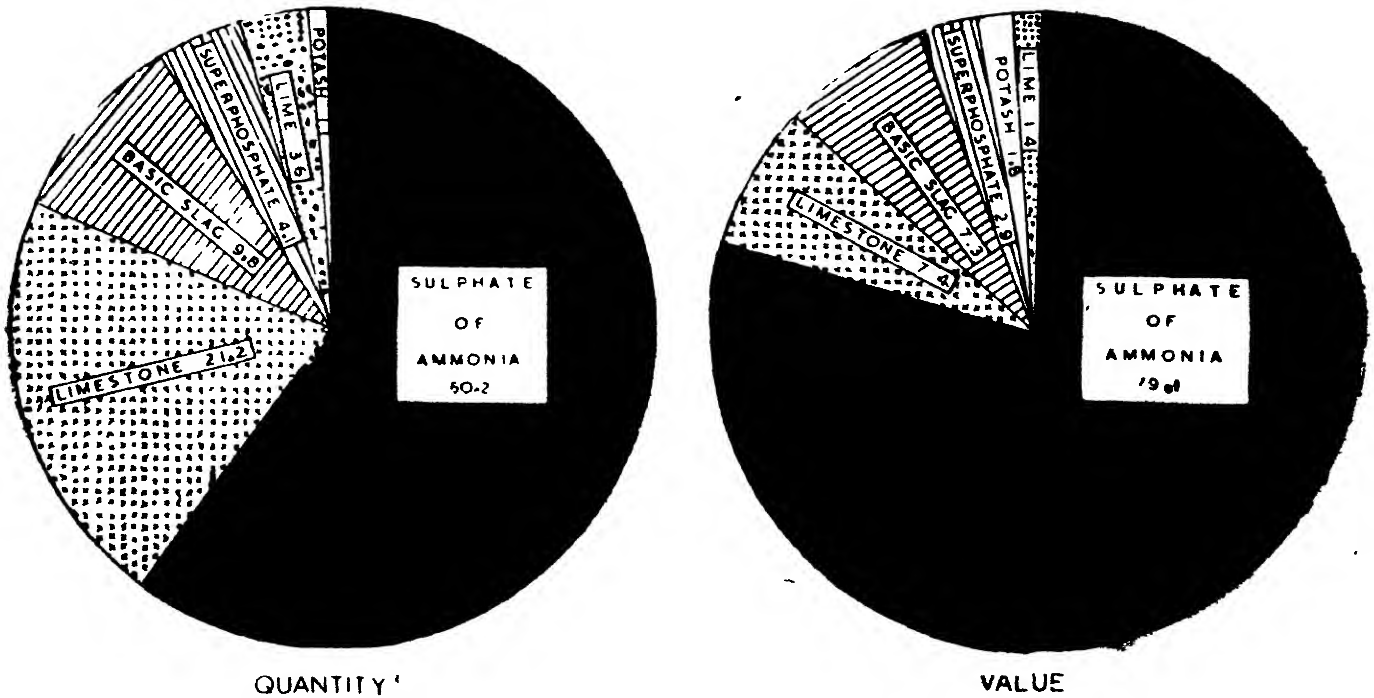

FIG. II.

Relative Quantities and Values of Fertilisers used on British Guiana Sugar Estates in 1937.

TABLE VII.

QUANTITIES OF FERTILISERS USED ON BRITISH GUIANA SUGAR ESTATES, 1933—1937.

FERTILISER	Tons					Per cent. of Total				
	1933	1934	1935	1936	1937	1933	1934	1935	1936	1937
Sulphate of ammonia	7,274.56	7,932.10	8,917.00	10,487.97	9,834.65	53.0	51.6	54.6	62.4	60.2
Lime	3,129.85	3,533.25	2,274.70	964.30	593.92	22.8	23.0	13.9	5.7	3.6
Basic Slag	1,249.05	1,254.80	1,472.10	1,772.20	1,596.80	9.1	8.2	9.0	10.6	9.8
Superphosphate	1,002.60	1,171.00	1,091.30	761.00	676.92	7.3	7.6	6.7	4.5	4.1
Limestone	924.50	1,286.70	2,450.50	2,622.27	3,461.99	6.7	8.4	15.0	15.6	21.2
Sulphate of potash	150.35	168.70	138.90	191.77	172.71	1.1	1.1	0.8	1.1	1.1
Miscellaneous	1.45	11.70	..	11.00	5.00	...	0.1	...	0.1	...
TOTAL	13,732.36	15,358.25	16,344.50	16,810.51	16,341.99	100.0	100.0	100.0	100.0	100.0

TABLE VIII.

VALUES OF FERTILISERS USED ON BRITISH GUIANA SUGAR ESTATES 1933—1937.

Fertilisers.	$					Per cent. of Total					Per Ton $				
	1933	1934	1935	1936	1937	1933	1934	1935	1936	1937	1933	1934	1935	1936	1937
Sulphate of Ammonia	284,681.72	310,268.18	334,885.63	395 970.73	375 273.90	71.3	71.0	74.1	79.3	79.1	39.13	39.12	37.56	37.75	38.16
Lime	38.263.01	42,072.23	23,092.19	11.166.60	6,861.58	9 6	9.6	5.1	2 2	1.4	12.23	11.91	10.15	11.58	11.55
Basic Slag	30,453.02	29,662.35	33,072.79	38,302.14	34,465.03	7 6	6.8	7.3	7.7	7.3	24.38	23.64	22.47	21.61	21.58
Superphosphate	26.212.45	29,940.54	27,039.67	17,897 38	13.960.48	6.6	6.9	6.0	3.6	2.9	26.14	25.57	24.78	23.52	20.62
Limestone	9,619.38	14,100.67	27.428.78	25.670.81	35,241.44	2.4	3.2	6.1	5.1	7 4	10.40	10.96	11.19	9.79	10.18
Sulphate of Potash	9.767.73	10,299.94	6,594.23	10,107.82	8,481.43	2.5	2.4	1.4	2.0	1.8	64.97	61.05	47.47	52.71	49.11
Miscellaneous	86.65	539.29	—	499.85	331.25	—	0.1	—	0.1	0.1	—	—	—	—	—
TOTAL ...	399,083.96	436,883.20	452.113.29	499,615.33	474.615.11	100.0	100.0	100.0	100.0	100 0					

SELECTED ARTICLE.

EDIBLE COCONUT OIL.*

BY

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(*Director of Research and Technological Chemist, Coconut Research Scheme.*)

Refined coconut oil, either alone or in admixture with similar fats such as Palm Kernel and Babassu Fats, has been sold for edible purposes in Europe and elsewhere under a wide variety of trade or proprietary names. Among the best known of these (some of which are still protected by registration) are Cocolardo, Cocoline, Lactine, Laureol, Nucoline, Nutrex, Nutto, Palmine, Vegetaline and in India, Messrs. Tata's well known Cocogem. As generic names for this type of edible fat have been used, Nut Lard, Vegetable Lard and Vegetable Butter.

It has been pointed out that reference to these preparations as "Vegetable Butters" (and similarly in German "Pflanzenbutter," and in French "Beurre de coco") is unfortunate, since in temperate climates they are pure white, odourless and tasteless edible fats, which are not plastic and contain no milk constituents as do butter and margarine. In Ceylon and the tropics generally coconut and similar oils are liquid and this point does not arise, since the word "butter" will not in any case be applicable.

The present article has been written since many inquiries have been received by the writer on the possibility of the local preparation and marketing of an edible grade of coconut oil. Some analytical figures obtained in connection with such inquiries are included.

STANDARDS OF EDIBLE COCONUT OIL.

Up to any point short of severe rancidity any coconut oil could in a sense be described as edible. *Chekku* oil, which may contain up to 2 per cent. of free fatty acid and may be of dark colour and strong odour, is consumed locally, but would by no means be reported by an analyst as of "edible grade". Indeed for edible coconut oil used as such and in the manufacture of margarine, stringent standards have been laid down. For example a Committee of Analysts to the Ministry of Food in Great Britain in 1919 required "fine edible coconut oil" to contain less than 0.1 per cent. of free fatty acid (as lauric), not more than 0.5 per cent. of moisture or 1 per cent. of unsaponifiable matter. The oil has also to be free from suspended impurities, and sweet and neutral in taste and odour. American authorities also lay down limits of colour; *viz.*, not more than 12 yellow and 2 red units on Lovibond's Equivalent colour scale.†

*Reprinted from the "Tropical Agriculturist" of Ceylon, Vol 89, No. 5, November 1937.

†This is not the same scale as referred to by the British Standard Specification.

The oil further has, of course, to comply with standards laid down for coconut oil of any grade, *e.g.*, in the case of the British Standard Specification, the refractive index at 40°C. must be between 1.4485 and 1.4492, and the iodine value between 7.0 and 9.5, whilst the saponification value should not be lower than 255.

Commercially, oils of such high grade have almost always been subjected to processes of refining.

REFINING PROCESSES.

For the purposes of the present article it is unnecessary to give details of commercial refining processes, but it will be as well to mention the principles involved. It will be clear that to convert, say, a copra oil of ordinary mill grade to a refined oil meeting the specifications outlined above, four main stages of purification are necessary ;

(a) Filtration or sedimentation to remove suspended impurities. Under this also may be included treatment to remove mucilaginous impurities which may escape removal by filtration.

(b) Removal of free fatty acid by means of alkali treatment.

(c) Decolorization.

(d) Deodorization.

Industrially, free fatty acid is almost always removed by means of caustic soda in slight excess (about 0.2 per cent.) of the theoretical amount. After the soap so formed has been removed the oil is washed and dried, and the decolorization or bleaching treatment follows. This is effected by treatment with activated charcoal and/or fuller's earth, followed by filtration. In the last stage the oil is treated in a vacuum apparatus with superheated steam which causes the odoriferous constituents to be distilled off. Technical details of this last operation are often strictly guarded as trade secrets.

On an industrial scale these operations require complicated plant and technical control at all stages. Such plants do not, of course, exist in Ceylon and it is extremely doubtful whether any potential demand exists sufficient to encourage anyone to invest capital in refining plants.

SMALL SCALE REFINING.

It is possible to refine a crude oil to a large extent by small scale methods. For example, the Department of Industries, Madras, has published a bulletin describing simple methods of refining oils, mostly devoted to describing the removal of free fatty acid by means of such alkaline reagents as lime, soda and silicate of soda. Bleaching with charcoal and/or bleaching earths can be adapted to a small scale and improvement of odour achieved, as is indeed done with *Chekku* oil, by simple boiling with water.

Refining Losses.

On such a small scale, however, refining losses are considerable. A. P. Lee of the India Refining Co., Philadelphia, published in 1924 an interesting account of coconut oil refining. The losses in refining an oil of f.f.a. (lauric) 2.58 per cent., colour (Lovibond scale) 35.1 yellow, 5.85 red, to an oil of f.f.a. 0.08 per cent., colour 4.01 yellow, 0.51 red, amounted to 6.1 per cent. of which 5.5 per cent. was removed as acid oil for soap stock. On a small scale the losses are vastly in excess of this.

Domestic Preparation of Oil in Ceylon.

It is doubtful whether there is any necessity to attempt to give instruction in refining coconut oil to the local villager. When small quantities of a good oil are required they are prepared locally by the domestic method which will be familiar to local readers.

The usual well-known procedure is to grate the fresh kernels using the ordinary domestic scraper or hiramanai found in every Ceylon household. The grated meat with added water (about a pint to a nut) is hand squeezed and the resulting emulsion strained. A second squeezing after adding more water is usually given and even a third treatment by boiling with water and again squeezing. The emulsion of oil and water is boiled down until all the water is removed and clear oil is finally poured off from the caramelized residue.

The oil yield is naturally low in comparison with that of commercial expression of oil copra, and attempts to produce oil on a large scale by a modification of this process both in Ceylon and elsewhere have met with little success. An English Patent (No. 10,601/1914) claimed "a process for the extraction of oil from the coconut and other nuts, consisting of reducing the kernel or flesh of the nuts to small pieces, adding water to about the bulk of the flesh and well mixing, subjecting the mixture to a process of grating, collecting the essential cream of the flesh produced thereby and laying the same on sieves and subjecting it to pressure to precipitate the essential cream of the flesh and water, &c., &c." Plant is described for carrying out these and subsequent operations, which are seen to resemble closely the hand methods described above. This process does not appear to have been worked successfully.

Parker and Brill in the Philippines in 1917 found that when freshly grated coconut meat was pressed at 1,000 lb. per square inch, over 60 per cent. of oil remained in the cake. By treating the material with water and steam 80 per cent. of the oil could be obtained by pressing, it being found best to separate the oil by chilling the emulsion to 60°F.

80 per cent. of the oil present seems to be about the best yield obtainable by hand pressing and it will be noticed that the domestic use of water and boiling to get further oil from second and third squeezings agrees with the results of Parker and Brill's scientific investigations. Six nuts are reckoned locally to give a bottle of oil (about 670 gms.) and a trial under the writer's supervision

gave from six nuts 760 gms., the nuts being of a size which would have given about 900 gms. of oil if converted into copra and hydraulically pressed.

The oil obtained in this trial was yellow in colour, with a strong but sweet odour of the nut, and f.f.a. (lauric) 0.12 per cent. It is referred to as No. 4 in the table and the oil from a similiar trial as No. 3. Such oil is fairly satisfactory in keeping properties; indeed the scientific literature contains some reference to it from this point of view. Lewkowitsch, for example, in his standard work states that "if the oil is prepared from fresh kernels by boiling (as is done on the Malabar coast and to some extent in Ceylon)......it undergoes little change."

MANUFACTURE OF OIL FROM FRESH KERNELS RAPIDLY DRIED.

Since it is very unlikely to be economic to erect refineries in Ceylon, and since the domestic method of making an edible oil does not seem likely to be successfully adapted to a larger scale, the question arises whether any other method suggests itself for preparing coconut oil of edible grade without the necessity of refining.

The only likely method, which has been tried twice on a fairly large scale is to disintegrate fresh kernels in the same way as is done in the preparation of desiccated coconut, but without removing the brown skin; to dry the disintegrated kernels in desiccators to the usual D.C. standard and at once to express the oil from the product. The oils so obtained had the analytical characteristics given as Nos. 5 and 6 in the table. They were not completely odourless, though nearly so, and had a bland taste but otherwise would be regarded as up to the edible grade. For local sale it is possible that less stringent standards would be necessary as regards odour—a slight sweet odour and taste of coconut might not be objected to.

This oil was sold at the ordinary price of White Oil as there was no special demand for oil of a special grade in small parcels. Retail sale was not, however, attempted.

ANALYTICAL FIGURES, ABNORMAL AND OTHERWISE.

The table of analyses summarises results obtained on various samples submitted by enquirers, some of whom have attempted small scale refining methods, and special methods of preparation (of which the writer has not always been informed). Other figures from the literature are given for comparison. It will be noticed that some samples give abnormal figures for iodine and saponification values and for refractive index. In these cases it is not suspected that the samples have been adulterated; to obtain a waterwhite oil, the samples have in many of these instances been prepared from the white meat only. It is well known that "paring" oil obtained as a by-product in desiccated coconut manufacture has an average iodine value much higher than that of ordinary oil, a lower saponification value and density, and a higher refractive index. Correspondingly, oil from the white meat, or pressed from desiccated coconut, has a lower iodine value and refractive index, and a higher saponification value.

Cruz and West of the Philippines reported an analysis on white oil from desiccated coconut, with the results shown as No. 10 in Table I.

TABLE I.

	Usual standards for edible coconut oil	1 Proprietary brand examined in writer's laboratory.	2 Sample of deodorised oil examined by writer.	3 "Domestic" Ceylon Oil (a)	4 "Domestic" Ceylon Oil (b)	5 Oil from fresh dried disintegrated whole kernels. (a)	6 Oil from fresh dried disintegrated whole kernels. (b)	7 Locally prepared samples of various origin received in the course of advisory work (a)	8 Locally prepared samples of various origin received in the course of advisory work (b)	9 Solvent extracted oil from Ceylon Desiccated Coconut.	10 Philippine sample from white meat. Ref. Cruz & West.
Density $d_4^{30^\circ}$	...	0.9154	..	...	..	0.9150	0.920	0.9150	..	...	0.9150
Refractive Index	1.4485—1.4492	1.4492	1.4488	1.4487	...	1.4491	1.4488	1.4483	1.4481	1.4482	1.4484
Iodine value	7—9.5	8.6	8.2	7.7	...	8.2	8.1	5.9	6.0	5.5	5.4
Free fatty acid (Lauric) %	not above 0.10	0.10	0.10	0.21	0.12	0.10	0.07	0.15	0.05	0.10	0.05
Saponification value	not below 255	258	259	263.8	...	257	260	263	262.4	261	261.4
Reichert-Meissl value	7—8	7.7	...	...	...	...	...	..	...	...	...
Polenske value	15—20	18.0	...	...	...	...	...	...	...	..	...
Colour	Lovibond Equiv. scale 12Y 2R	almost colourless	colourless	pale yellow	pale yellow	almost colourless	slightly cloudy but almost colourless	water white	almost colourless	colourless	water white
Odour	sweet and neutral	odourless	neutral	slight odour of the nut	strong but sweet odour of the nut	slight odour of the nut	odour very faint sweet	strong odour rancid	odour strong but sweet of oil	slight of solvent	almost odourless
Taste	do.	neutral bland	do.	nutty bland	taste similar	sweet bland	taste bland	...	nutty bland	...	...
General remarks	unsaponifiable not over 1.0%	a good refined oil	...	...	...	of edible grade except slight odour	as 5 (a) but better	not up to edible grade particularly on account odour	moisture 0.17%, a fairly good oil	...	...

In the case of domestic oil the scraping stops somewhat short of including all the brown parings, so that these oils show iodine values slightly less than ordinary oil, but not so low as those from the white meat only.

The percentage of unsaponifiable matter has not been determined on the samples reported here. At one time it appears that paraffin wax or heavy paraffin oil has been added to coconut fat (in temperate climates) to give it a consistency more resembling butter. The latter found in a sample of "vegetable butter," 3.9 per cent. of unsaponifiable matter of iodine value 2.65, saponification value 0, refractive index 1.475 at 40°C. The writer has examined a similar paraffin oil, which, it was stated, was used as an addition to edible oils. This had iodine value 2.3, saponification value 0.2, refractive index 1.465 at 40°C. Such additions are unlikely in Ceylon; to liquid oils there would be little point in them, and as mentioned above, they have not been looked for in local samples.

Coconut "Stearin" and "Olein".

Edible coconut oils of various melting points are obtained by the process known as "winterising". By pressing the partly solidified oil at various temperatures it is separated into higher and lower melting portions, the proportions depending on the temperature and pressure. The higher melting portions are referred to as "coconut stearin" and the lower as "coconut olein". The analytical constants of these will lie respectively on each side of the average values for ordinary oil. Bolton gives the following usual limits, but mentions that "there are manufactured products made in a great variety of melting points, according to the extent of pressure, and only the very extreme figures are given, and practically all commercial samples yield figures well between these limits".

	Coconut Stearin.		Coconut Olein.	
	Usual Limits.	Typical specimen (refined).	Usual Limits.	Typical specimen (refined).
Melting point °C.				
Incipient fusion	...	29	...	21
Complete fusion	26—31	30	16—22	23.5
Solidifying point °C.	24—29	27.4	14—22	19.1
Saponification value	252—255	252.1	257—262	258.3
Refractive Index 40°C	1.4485—1.4487	1.4486	1.4492—1.4494	1.4493
Iodine Value (Wijs)	2—7.9	4.1	11—15	14.2
Sp. gravity 99°/15°C	0.860—0.869	0.866	...	0.870
F.f.a. (lauric)	0.2—5.0	0.1	3.13	0.2
Reichert-Meissl value	4.5—6.0	5.6	8.10	9.2
Polenske value	8.0—15.0	10.7	17—20	19

*Approx. from Zeiss butyro-refractometer readings

A. P. Lee gives interesting particulars of the working of this process and describes a large scale trial in which the oil as described above was kept between 12.5—15.5°C. for 40 to 60 hours and then pressed, there being obtained 38.2 per cent. of hard butter or stearin of solidifying point 26.68°C. and 60.95 per cent. of olein of S.P. 20.3°C.

It will be apparent that some care has to be exercised in interpreting the analysis of edible coconut oils. Oils from the white meat only have low iodine values like "stearin," but whereas the former tend to have saponification values above the average, the reverse is true of the latter. Similarly the iodine values of "olein" (above the average for ordinary oil) may approach those of commercial parings oil, but the latter have saponification values well below the average for ordinary oil, whilst "oleins" are about the average or a little above. Coconut "stearin" is more used indirectly for edible purposes than directly, *e.g.*, as a substitute for cacao butter in chocolate and confectionery.

Hydrogenation.

Coconut oil can be hardened by the process of hydrogenation. The melting point can be raised to about 44.5°C, when the iodine value is reduced to 1 0. The saponification value is not greatly altered.

Economic Considerations.

Whilst coconut oil hardened by hydrogenation and high melting coconut stearin might be useful in the tropics as edible fats for cooking, etc., it is very unlikely that the processes for their manufacture could be economically worked in Ceylon. Enquiries are occasionally received by the writer asking for details of such processes—particularly hydrogenation—to which the reply is generally made that the processes require extensive plant and expert technical management, and that there is little likelihood of their inception locally.

It is said that whilst it is true that local demand would not justify an edible oil industry, there is a possibility of an export business. This is, in the writer's opinion, also unlikely. Neighbouring countries are all themselves oil (and particularly coconut oil) producing countries. India in particular already protects her oil crushing industry by a heavier duty on oil than on copra. Many European and other countries where refining interests exist put a heavy tariff on edible grades of oil, whilst admitting unrefined oil at lesser rates.

Any attempt at retailing edible oil in Ceylon is likely to remain a small-scale business, and the oil either prepared by the simpler method outlined, or refined by methods applicable on a small scale.

Vitamins in Coconut Oil.

Whilst there is some evidence that coconut oil in its fresh state contains some vitamin A and vitamin E, it is not a good source of any vitamin, and vitamins are unlikely to be present at all in the refined oil. Some manufacturers therefore add vitamin preparations and a well-known proprietary brand in

India is stated to contain added vitamin D. Vitamin preparations can be purchased from pharmaceutical houses, but their local preparation or use is not likely to become a possibility of interest, the object of health authorities being more to ensure that the local dietaries contain sufficient vitamins in other natural foodstuffs used.

Addition of Flavouring Matters.

Flavouring matters have been added to refined coconut and other oils.

As recently as 1929 it was shown that the substance responsible for the aroma of butter is diacetyl. This has been added to margarine in small traces to imitate the odour of butter and its use in edible coconut and other fats has been tried.

Other Modifications.

Processes have been devised to render coconut fat plastic so as more to resemble lard or butter in texture. The fat is submitted to processes of foaming with air or carbon dioxide and of kneading to the required consistency. These do not in the ordinary way apply to the tropics where the fats are liquid oils.

Keeping Qualities.

The older text-books on oils and fats used to mention coconut oil as one of the most susceptible to rancidity. This was true of the inferior copra oils formerly shipped, but as mentioned above oil prepared from fresh kernels or any oil initially sound keeps well, as do well refined oils, particularly in air-tight containers protecting the oil from light and air.

The stringent standards laid down have the keeping quality of the oil in view as well as its initial soundness.

The use of preservatives such as benzoic or chlorobenzoic acids or of anti-oxidants should not be necessary, particularly in an oil intended for quick local consumption.

Summary.

The present article reviews the processes used commercially in the preparation of coconut oil of edible grade, and mentions the modified forms under which such oil is marketed. From the local point of view the opinion is expressed that large-scale refining and other processes are unlikely to be worked in Ceylon, as there is unlikely to be an extensive local demand and the possibilities of export are doubtful for tariff and other reasons.

The preparation of coconut oil suitable for edible purposes locally on a *smaller scale for retail marketing may be possible ; processes are suggested for producing an initially sound oil needing no refining, and mention made of the* possibility of small-scale refining.

Analytical reports on samples of various kinds examined in the writer's laboratory are tabulated, and some figures from the literature given for comparison.

NOTES.

Boron in Agriculture.—In Research Bulletin No. 5 (West of Scotland Agricultural College Plant Husbandry Dept.), R. W. G Dennis and D. G. O'Brien draw attention to the part played by boron in agriculture.

The interest in boron as a component of field crops arose in 1910, when Agulhon published results of field tests, in which he obtained increase in dry weight of 50 per cent. for maize, 21 per cent. for colza, and 32 per cent. for turnips, as a result of applying 0.5 grammes of boron (as boric acid) per square metre. Yet there was no proof that boron is essential for plant growth until Brandenburg in 1931 demonstrated that boron deficiency occurs in the field, and is the underlying cause of dry-rot in sugar beet and mangolds. Boron almost immediately took its place in the list of accepted fertilizers.

Boron in the Soil.

Although boron is an essential component of some 56 minerals, the majority of these are rare or of restricted occurrence, and the only widespread member of the group is tourmaline—a boro-silicate of aluminium and iron. It is doubtful, however, if tourmaline forms a source of boron available as plant food, as it is resistant to weathering, but its occurrence in the field in rocks or soils may be an indication that boron deficiency is unlikely in that area. On the other hand, the comparatively high boron content of sea water led to the suggestion that the boron content of soils and rocks is derived from the sea, and thus clay soils of marine origin are usually adequately supplied with this element.

Boron Deficiency in Some Tropical Crops.

Sugar Cane: Symptoms of boron deficiency in sugar cane grown in water cultures have been described in detail by Martin, who employed cuttings of the Varieties H 109, P.O.J 36, P.O.J. 2878, Yellow Caledonia and Badila, previously rooted in black volcanic sand.

The most marked effect of boron deficiency was the retardation of growth. Usually, after one or two months the first definite symptoms developed as minute elongated watery spots on the young leaves. These lesions elongated parallel to the vascular bundles and resulted in a striping of the leaves. Older lesions exhibited a dark red centre surrounded by chlorotic tissue, and, finally, fracture of the dead tissue occurred. Young leaves were short, narrowed at the base, and chlorotic, with irregular brown edges. The symptoms also included enlargement of the lower cells of the bundle sheath in the leaves, sometimes so marked as to cause the formation of elongated gall-like bodies on the lower leaf surface. The bundle fibres were poorly developed and lacked the normal silica

content. Martin remarks that the symptoms observed in his cultures very closely resemble those of Pokkah-boeng disease of sugar cane, associated with the fungus *Fusarium moniliforme* Sheldon, and suggests that the severity of this disease is related to the degree of boron deficiency in the sugar cane plant.

Rice. In a series of pot cultures in a weakly acid clay soil Tokuoka and Morooka showed that a concentration of 20 parts per million of boron was toxic to the plants. Larger quantities of boron led to extensive growth of *Cladosporium* on leaves and grain. Later they reported that minute doses of boron increased the number of grain-bearing stems per plant and raised the yield of grain. Optimum growth was secured at a concentration of 0.4 parts per million of boron. They concluded that boron was not essential for the growth of rice, but did not determine the pre-existing boron content of the soil used.

Citrus: Haas and his fellow-workers have shown that in sand culture, boron to the extent of 0.2 parts per million of the culture solution is essential for the normal growth of citrus. The deficiency symptoms are summarized as follows: "Leaves curled along the midrib with the tip of the leaf curling downward: leaves coloured a brownish or yellowish green, often with a yellowing along the midrib; midrib or veins conspicuous, corky and split; and a progressive loss of affected leaves in the basipetal direction. In severe cases there is a tendency towards "multiple bud" formation due to new twigs dying when barely visible. When the bark of the internodes of the twigs, or in severe cases, that of the trunk, splits, an amber coloured gum oozes out. Eventually the cracks may widen so that the woody tissue is exposed. In severe cases the apical portion of the branch dies back. The roots become dark brown in colour and fail to elongate and in advanced cases the rootlets decay. On adding a suitable concentration of boron to the culture solution the symptoms of decline disappear".

Maize: The evidence so far available indicates that little advantage can be expected to accrue from the application of boron to maize.

Tobacco: M'Murtrey found in water culture experiments that the effects of boron deficiency were usually apparent within a week or ten days of the transferring of a plant to a nutrient solution lacking this element. The first visible effect was the manifestation of a light green colour of the leaves making up the bud, with the base of the individual leaf assuming a lighter green than the tip. When this appears, the bud has ceased to grow and has a somewhat drawn appearance. This is followed in a day or so by the breakdown of the tissue at the base of the young leaves making up the bud.

In the Deli district of Sumatra a disease called topziekte of tobacco occurs which corresponds for the most part with those of boron deficiency, and the addition of boric acid at the rate of 3 milligrammes per plant was effective in greatly reducing the incidence of this disease. It was later found by Meurs that applications heavier than 6 milligrammes per plant would probably be toxic.

In 1935 M'Murtrey described the occurrence of boron deficiency, as exemplified by the death of the terminal bud and crinkling of the upper leaves, in field plots laid down on sandy soil in Maryland, U.S.A. Boric acid was applied at the rate of 5 lbs. per acre and completely prevented further development of the disease.

Cotton: By means of sand cultures carried out on a large scale in the open Eaton has shown that boron is essential for the normal growth of cotton. Plants grown without sufficient boron became stunted, the leaves were buckled and irregular in shape, and most of the flower buds and young bolls were shed. A concentration of 1 part per million of boron was sufficient to suppress the marked deficiency symptoms, but the largest plants and greatest number of bolls were obtained with a nutrient solution containing 10 parts per million, although signs of toxicity were visible at this higher concentration. Analysis of the plants showed that boron is accumulated mainly in the leaves and Eaton estimated that as much as 10 lbs. borax per acre per annum might be removed from the soil.

Tomato · The symptoms of boron deficiency in tomato are death of the growing points of shoot and root with stimulation of development of secondary roots and axillary buds, together with thickening and curling of the leaves. Internal symptoms include brown discoloration of the cell walls, enlargement of the phloem, and deformation of some of the thin-walled tissues. The tissues of the flower stalk also degenerate and the flowers die prematurely.

In Johnston and Fisher's experiments, approximately four times as many fruits set on plants supplied with boron as on boron-free plants. On the latter the fruit were covered with darkened or dead areas due to the breakdown of the cells.

D.W.D.

New Ornamental Plants introduced into the Botanic Gardens during 1937.—The Gardens are much indebted to the Arnold Arboretum of Harvard University for a large selection of seed of ornamental plants, some of which yielded very welcome innovations. Besides a number of species of Aristolochia, which flowered in the Rockery and nearby, there were several new shrubs, including *Dombeya Mastersii*, and *Strobilanthus isophyllus*, which latter made a good showing opposite the bandstand and elicited several enquiries as to its identity. A small Erythrina—*E. Senegalensis*—bloomed profusely at the end of the year, and more plants of it have been set out.

Apart from the usual purchases of seed of annuals and perennials for the borders, and a few new rose plants, other introductions from seedsmen and nurseries included a large collection of dahlias from Holland, which attracted considerable attention when they were in bloom, a new species of Lonicera (*L. Tellemanniana*), which has not yet been put out, and a pretty pale mauve Achimenes which has flowered well in the Rockery.

A correspondent in Florida, with whom plants have been exchanged, sent us a good selection of Amaryllids, most of which however, have not yet matured sufficiently to flower; one or two Amaryllids were also obtained from another correspondent in South Africa.

From Bermuda we received a new purple variety of Salvia, which flowered well in the borders, and has already found its way into some gardens in the town, a yellow Buddleia, which has yet to flower, and some Arum Lily seed.

Some palm seed came to us from Porto Rico, and to another friend in Florida, we were much indebted for seed of an ornamental bamboo, *Dendrocalamus strictus*.

E. B. M.

Legislation.—As a reminder to the public, attention was drawn in Department of Agriculture notice No. 693 to new legislation introduced into Trinidad affecting the importation of plants.

The importation into Trinidad of cacao plants and cacao beans from this Colony is prohibited. A certificate of origin stating that the following fruits and vegetables have been imported into British Guiana must be submitted before importation into Trinidad is allowed: pineapples, yams, sweet potatoes, tannias, eddoes and dasheens. Plants, seed, cuttings and fruit of citrus, sugar-cane, bananas and coconuts may be imported into Trinidad only if a permit from the Director of Agriculture of British Guiana is obtained.

An Order-in-Council under Section 3 of the Plant Diseases and Pests (Prevention) Ordinance, 1935, prohibits the importation into this Colony of Grapefruit from Trinidad and of all citrus fruit from the other islands of the British West Indies.

British West Indies Fruit and Vegetable Councils.—The first joint meeting of the Eastern and Western Group Councils and the third meeting of the Eastern Group Council were held at the Imperial College of Tropical Agriculture, Trinidad, from February 9 to 15, 1938. The chief recommendations are:—

RECOMMENDATIONS.

1. *Grapefruit.*

Recommendations 1 and 2 of the West Indian Intercolonial Fruit and Vegetable Conference (Jamaica) 1933 relating to grapefruit and oranges are endorsed by this meeting with the exception that it is recommended that future plantings of grapefruit should be restricted to the seedless varieties.

It is also recommended that further extensions of grapefruit planting should only be undertaken with caution and after careful consideration of the present world position.

2. *Mangoes.*

Recommendation No. 5 of the West Indian Intercolonial Fruit and Vegetable Conference (Jamaica) 1933 concerning mangoes is endorsed by this meeting but it is noted with regret that the absence of suitable and frequent shipping facilities among the Colonies of the Eastern Group makes development of a profitable trade problematical. It has also been noted that the Canadian market offers little prospect of development for this commodity.

3. *Avocado Pears.*

This meeting while endorsing Recommendation No. 6 of the West Indian Intercolonial Fruit and Vegetable Conference (Jamaica) 1933 concerning avocado pears desires to draw attention to the need for further experiments with West Indian and other varieties in order to provide the planting public with types suitable for export.

4. *Pineapples.*

This meeting endorses Recommendation No. 7 of the West Indian Intercolonial Fruit and Vegetable Conference (Jamaica) 1933 concerning pineapples and finds that as there has been no improvement in the position regarding either fresh or canned pineapples there appears to be no object in carrying out extensive experimental work with this crop at present.

5. *Pooling of Information.*

The meeting has given consideration to Recommendation No. 10 of the West Indian Intercolonial Fruit and Vegetable Conference (Jamaica) 1933 concerning the pooling of information and finds that normally there is insufficient material for the regular publication of a bulletin of the type referred to in that Recommendation and considers that the Councils of the Eastern and Western Groups should arrange for the circulation of information as it becomes available.

6. *Marketing Intelligence Officer.*

This meeting notes with satisfaction that the Eastern Group Trade Commissioner in Canada has undertaken many of the duties which would fall upon a marketing Intelligence Officer such as was suggested in Recommendation No. 16 of the 1933 Conference and that Jamaica has made an appointment of a Development and Marketing Officer whose functions are of a similar nature. It is also noted that the Bermuda Government has established the necessary machinery for keeping in touch with Canadian markets.

In these circumstances this meeting feels that the appointment of a whole-time West Indian Marketing Intelligence Officer in Canada is at present unnecessary but recommends that the closest contact should be maintained between the Eastern Group Trade Commissioner, the Marketing Division in Jamaica and the Department of Agriculture in Bermuda.

7. *Co-operation between citrus marketing organisations.*

This meeting having arranged a joint meeting between the Co-operative Citrus Growers' Association of Trinidad and Tobago and the Dominica, Jamaica

and British Honduras delegates recommends that the closest contact should be maintained in the future between the official citrus marketing bodies in Trinidad, Jamaica, Dominica and British Honduras with a view to the establishment at a later date of a West Indian Citrus Fruit Exchange.

8. *Re-establishment of an official agricultural department in Bahamas.*

This meeting records with satisfaction the efforts of the Bahamas towards the institution of more orderly methods of marketing tomatoes and suggests that it is desirable that estimates of acreage and production of this crop in the Bahamas should be made available as early as possible for the information and guidance of other producing Colonies. It is therefore hoped that the Government of the Bahamas will find it possible to re-establish the official agricultural department.

9. *Bananas.*

In view of the great importance of the banana as a cash crop in many of the Colonies of the Eastern Group this meeting recommends that every endeavour should be made to stimulate further production.

10. *Banana breeding.*

In view of the progress which has been made in breeding varieties immune to Panama disease and *Cercospora* leaf spot this meeting strongly recommends that early steps be taken to provide the geneticists engaged in banana breeding with wild varieties of bananas necessary to serve as suitable parents for the purpose of breeding, as soon as possible, an immune variety with suitable commercial characters.

11. *Low Temperature Research Stations.*

This meeting recommends that the officers of the Low Temperature Stations in Trinidad and Jamaica should collaborate in drawing up a schedule of optimum storage temperatures at which West Indian fruit and vegetables should be transported and that this schedule should be revised when necessary in the light of further investigations. It is further recommended that the attention of shipping companies serving the West Indian area should be drawn to the necessity for adopting these temperatures as standards.

12. *Measures designed to control spread of Diaprepes* spp.

This meeting recommends that all fruit, vegetables and ground provisions for export to Colonies where the weevils (*Diaprepes* spp.) are not known to exist from any country or countries where the weevils (*Diaprepes* spp.) are known to exist must be accompanied by a certificate issued by a Government Inspector in the country of origin to the effect that the produce is reasonably free from foliage, trash and soil.

13. *The Anglo-United States and the Canada-United States Trade Agreements.*

This meeting desires to draw the attention of the Secretary of State for the Colonies and the Canadian Goverment to the serious effects on the British West Indian fruit and vegetable industries which have resulted from the Canada-

United States Trade Agreement. These effects have been most marked with citrus and miscellaneous vegetables other than tomatoes.

It is noted with satisfaction that the continuation of the Canadian Preference on British Colonial tomatoes has been ensured through the Trade Agreement between the United Kingdom and Canada. A reduction or abolition of this preference would result in a serious setback to the tomato industries of the West Indian Colonies. The continuance of this preference is therefore essential.

Through the abolition of the tariff on American oranges from January to April in each year the West Indian trade in this commodity has received a severe blow, since the peak of Jamaica production is in late December and January. An extension of the protected period for West Indian oranges in Canada to include the month of January is therefore most desirable and this additional month could be exchanged for an even longer period of free duty for American oranges in the summer months apparently without any present damage to Empire trade in the commodity.

It is hoped to institute an advertising campaign in Canada for British West Indian limes, but with the existing *ad valorem* Intermediate and General Canadian tariffs on this commodity the West Indian Islands have little protection from foreign competition. It is therefore desirable that, in the interests of these Colonies, the Canadian Government be asked to amend the tariff on foreign limes to a specific duty of 2c. per lb.

It is further recommended that the assistance of the Secretary of State for the Colonies be sought to represent the desirability of concession being given to West Indian limes and lime juice entering United States in the Anglo-United States Trade Agreement, negotiations for which are now proceeding.

14 *Empire preference on citrus fruit entering the United Kingdom.*

This Meeting having given consideration to reports of the possibility of the general rate of duty on citrus fruit on importation into the United Kingdom being reduced, recommends that the attention of the Secretary of State for the Colonies be drawn to the disastrous effects which such action would have upon the growing British West Indies citrus industry which was developed largely upon the recommendation of an expert who visited the West Indies in 1928 at the invitation of the Empire Marketing Board, a policy of development which was later confirmed by the Secretary of State following the receipt of the Report of the West Indian Intercolonial Fruit and Vegetable Conference convened by the Colonial Office and held in Jamaica in 1933: the meeting further recommends that the Governor of Trinidad be asked to forward this recommendation to the Secretary of State for the Colonies by telegram and that the memorandum of the Trinidad Chamber of Commerce Inc. which is fully supported by representatives of all the British West Indian Colonies and the Jamaica Imperial Association be forwarded by airmail.

15. *Preferences for British West Indian fruit and vegetables in Canada and the United States of America.*

This meeting views with regret that the abolition or reduction in Canadian preferences on West Indian vegetables has made trade in these commodities much more difficult and it is felt that the British West Indies have a fully justifiable claim to consideration by the United States for concessions, even if seasonal and for a limited quantity, on vegetables, citrus and other fruits entering the United States in return for the concessions granted to the United States of America by Canada.

The approaching negotiations for an Anglo-American Trade Agreement offer a suitable opportunity for putting forward these claims, and it is hoped that the Secretary of State for the Colonies will arrange for the fullest representation on behalf of the British West Indies.

16. *Freight Rates.*

This meeting notes with alarm recent increases in freight rates which have been coincident in most instances with a reduction in commodity prices and desires to seek the assistance of the Secretary of State for the Colonies in watching the interests of these Colonies in regard to freight rates. The meeting also hopes that Canadian National Steamships will maintain their sympathetic attitude towards producers in the West Indian Colonies and find it possible to remove the increases recently instituted in the Eastern group.

17. *Lime Growers Associations and a West Indian Limes Association.*

This meeting notes with satisfaction the successful formation of a West Indian Lime Oil Sales Company and recommends that lime oil producers in Colonies not yet affiliated to that Company should give favourable consideration to such central marketing organizations.

It is apparent that further progress in the marketing of limes and lime products can only be satisfactorily developed and extra production allowed for by means of centralised advertising directed through a joint West Indian association of lime growers and other lime interests. This meeting therefore strongly recommends the early formation of Lime Growers Associations in all the West Indian Colonies concerned to be followed by the formation of a West Indian Limes Association with the constitution recommended at the meeting of lime growers representatives held at the Imperial College of Tropical Agriculture on February 12th, 1938.

This meeting further recommends that this West Indian Association when formed should take steps to obtain the co-operation of lime interests in the Gold Coast.

It is further recommended that all West Indian lime producing Colonies should institute a system of export cesses or other contributions to provide funds for the West Indian Limes Association on the basis of 3d. per lb. on distilled lime oil, 6d. per lb. on ecuelled lime oil, 6d. per barrel on green limes and ½d. per gallon on top pulp juice exported.

This meeting also notes that Recommendation No. 3 of the West Indian Intercolonial Fruit and Vegetable Conference (Jamaica) 1933 relating to limes and lemons has not been followed by certain lime growers and while it does not appear practical to prohibit further plantings yet it is felt that the dangers of over-production are now more apparent than they were in 1933.

18. *Utilization of the services of the Colonial Marketing Board.*

This meeting strongly recommends that the possibilities should be explored of the means of utilising the services of the Colonial Marketing Board for the benefit of the West Indian fruit and vegetable industries, and that the collaboration of other bodies such as the West India Committee and the Canadian West Indian League should be sought to work with the official marketing services in the Colonies as well as the two Group Councils.

This meeting further recommends that the Commissioner of Agriculture, Imperial College of Tropical Agriculture, and the Development and Marketing Officer in Jamaica should be requested during their visit to the United Kingdom during the summer of 1938, to seek the assistance of the Agricultural Adviser to the Secretary of State for the Colonies and the Colonial Marketing Board in regard to expanding the markets for limes and lime products.

19. *United action by Colonial Governments.*

This meeting recommends that the Governments of the Colonies represented at this meeting should unite in making representations to the Secretary of State for the Colonies and other Governments on subjects of general importance relating to the fruit and vegetable industries although this should not preclude individual representations on matters more directly concerning a particular Colony.

Organisation of Intercolonial Trade in Fruit and Vegetables.

Arising out of the discussion on various trade matters, the view was expressed by Professor Dash that the time had arrived for the careful investigation of the Intercolonial trade in fruit and vegetables from the commercial as well as the quarantine aspects. The Conference fully endorsed this view. It was suggested that a Committee should be appointed to investigate conditions of the trade. The proposal is that each Colony should be asked to give an idea of the seasons of their main fruit and vegetables and the likely exportable surpluses for intercolonial trade. Such information would form the basis of possible trade agreements between the various Colonies, with a view to preventing competition of locally-grown produce with imported commodities of a similar nature. By careful regulation periodic gluts would be avoided and better prices ensured to producers as a whole. It would also help to make these Colonies self-supporting in regard to Caribbean grown fruit and vegetables.

NEWS.

His Excellency the Governor, accompanied by the Director of Agriculture, visited the economic farm unit at Toevlugt, West Bank, Demerara, on Thursday, April 21.

His Excellency also visited the Central Offices of the Department on Wednesday, June 15.

Sir Geoffrey Evans, Principal, and Mr. E. McC. Callan, Lecturer in Entomology, of the Imperial College of Tropical Agriculture, visited the Colony with a party of post-graduate students from April 6 to 15. These tours have become a regular feature and enable students to obtain first hand knowledge of the Colony's agricultural and forest industries and its economic problems. Such intercourse cannot but be of advantage to all concerned.

Mr. G. Milne, M.Sc., F.I.C., Soil Chemist to the East African Research Station, Amani, visited the Colony from April 8 to 19. Advantage was taken of this visit to discuss the different aspects of the soil and agricultural problems of the Colony.

Dr. D. S. Fernandes, Director of the Department of Agricultural Economics, Paramaribo, Suriname, paid a visit to the Department on April 19. It was a very welcome opportunity for exchanging views with Dr. Fernandes, especially in connection with the curing of Liberian coffee, a subject to which he has given considerable study.

Dr. Sant, Government Analyst, also of Paramaribo, visited the Department on May 13.

Dr. A. C. Smith of the New York Botanic Gardens, who had accompanied the Terry-Holden expedition to British Guiana, visited the Botanical Division of this Department on May 13 and 16. Dr. Smith made a large collection of plants in the Rupununi District, specimens of which are being sent to Kew.

Another visitor from New York was Judge Jacob Panken, who arrived on June 14.

The Director of Agriculture was on tour in Berbice from March 28 to April 1 and in Essequibo from April 30 to May 4.

During the period under review the Deputy Director of Agriculture paid visits of inspection to Anna Regina, Leguan, the banana experiment and economic farm settlement on the West Coast Demerara and to rice areas on the West Coast Berbice and the Corentyne.

The Botanist and Chemist visited the North West District, leaving Georgetown on April 25 and returning *via* Pomeroon on May 9. While in the district they inspected the Department's station and sub-station at Hosororo and Wauna respectively and visited a number of the chief landholders and farmers, with whom they discussed various matters of agricultural interest. In addition, a number of small grants were visited.

Major Thomas Bone, O.B.E., M.R.C.V.S., Government Veterinary Surgeon, left the Colony on 4 7/30 months leave prior to retiring. Major Bone joined this Department in 1928 after seeing army service in England, Ireland, France, India and Italy. After retiring from the army, the Major served for one year with the British South Africa Company, afterwards in Rhodesia, and became Chief Veterinary Officer to the Compania de Moçambique, Portuguese East Africa. He acted as Senior Veterinary Officer in South West Africa (Mandated Territory). Major Bone has served in British Guiana for about 10 years during which time a considerable enlargement in scope of the Department's livestock investigations and activities has taken place, the benefits of which can only be fully felt as time goes on. Results are, however, already apparent in the case of dairy cattle, especially in the areas adjoining Georgetown. His colleagues wish him every good fortune in his retirement.

Mr. James D. Gillespie, B.Sc., Agricultural Superintendent in this Department from January, 1930, has been promoted to the post of Agricultural Officer, Sierra Leone. Mr. Gillespie is at present stationed in Berbice and will leave for his new post in August next.

Officers of the Department who have already left or who will shortly be leaving the Colony on vacation are: Capt. F. Burnett, Deputy Director of Agriculture, L. D. Cleare, Entomologist, Major T. Bone, Government Veterinary Surgeon, C. H. B. Williams, Sugar Agronomist, H. E. H. Gadd, Rice Grading Officer, Miss V. Chan-Choong, Librarian.

During the absence of Major Bone and Mr. Gadd, Mr. H. A. Fraser, B.V.Sc., and Mr. H. D. Huggins, Agricultural Superintendent, have been appointed to act as Government Veterinary Surgeon and Rice Grading Officer, respectively.

The Report of the Committee which was appointed to enquire into matters affecting the rice industry was published as Leg. Co. Sessional Paper No. 1/1938. Mr. Percy W. King, Crown Solicitor, was Chairman, Capt. F. Burnett, Deputy Chairman and Mr. H. E. H. Gadd, Secretary.

His Excellency the Governor has been pleased to appoint a Committee to report on the advisability of establishing a central rice mill on the Essequibo Coast for the purpose of affording relief in that area.

A meeting of the Board of Agriculture was held at the Head Office, Department of Agriculture, on March 21 and a meeting of the Sugar Experiment Stations' Committee was held on June 13.

PLANT AND SEED IMPORTATION.

Introductions by the Department of Agriculture for the period March—May, 1938.

NAME	QUANTITY.	WHENCE SUPPLIED
Economic.		
Asstd Vegetable Seed	17½ oz.	H. G. Hastings & Co., U.S.A.
Cuttings, 12 cane varieties	3 of each	Plant Quarantine Station, Trinidad.
Derris elliptica	46 cuttings	St. Augustine Nursery, Trinidad.
Maize—I.C.M. 1	3 lb.	I.C.T.A., Trinidad.
I.C.M. 3 and 4	2 lb. each	do.
Mahogany Seeds	4 lb.	Dept. of Agriculture, Trinidad.
Nutmeg Seeds	500	do.
Soya Bean	1 lb.	I.C.T.A., Trinidad.
Ornamental.		
Colvillea racemosa	2 oz.	Dept of Agriculture, Trinidad.
Iresine verschaffeltii	3 plants	do.
Salvia farinacea var. *alba*	1 pkt. seed	do.
Brunfelsia nitida *Callistemon specisous* *Dalbergia sissoo* *Erythrina berteroniana* *Lysiloma sabiou* *Peltophorum brasiliense*	1 pkt. each	Secretary for Agric. Estacion Exptl. Agronomica, Cuba.
Colubrina ferruginea	3 oz.	do.
Anthurium Lilies	12 plants	Eden Flower Shop, Trinidad.
Dahlias (asstd.)	58 bulbs	Papendrecht Vandervoet, Sassenheim, Holland.
Roses	4 plants	H. G. Hastings & Co., U.S.A.
Roses (Double White Killarney)	2 plants	Peter Henderson & Co., New York, U.S.A.
Sweet Peas	6 pkts.	do.
Violet Tree	1 pkt.	Mayaguez Expt. Stn., Puerto Rico.

METEOROLOGICAL DATA—JANAURY TO MARCH, 1938.

Recording Stations & Months.	Rainfall. Total Inches.	Number of Days of Rain: Under ·10 Inch	·10 to ·50 Inch	·50 to 1·00 Inch	1·00 Inch to 2·00 Inches	Above 2·00 Inches	Total days.	Evaporation Inches	Air Temperature and Humidity. Maximum	Minimum.	Mean.	Humidity Mean.
Botanic Gardens.												
January ...	13·34	4	7	3	6	...	20	3·86	84·1	75·6	79·8	82·5
February ...	15 10	9	6	2	3	2	22	3 51	83 7	76·5	80·1	85·3
March ...	13·76	9	6	1	4	2	22	4·47	83·5	75·7	79·6	82·9
Totals	42·20	22	19	6	13	4	64	11·84				
Means	...	...	...	...	...	...	...	...	83 8	75·9	79·8	83·6
Berbice Gardens.												
January ...	10·55	8	9	3	4	...	24	..	84 6	74·9	79·7	82·9
February ...	15·99	3	9	6	3	2	23	...	90 1	75·3	82·7	84·6
March ...	15 67	7	9	3	5	1	25	..	85·7	74·5	80·1	85·9
Totals	42 21	18	27	12	12	3	72	..				
Means	...	...	...		...	...	...	...	86 8	74·9	80 8	84·5
Onderneeming.												
January ...	15 43	2	7	3	4	2	18	...	86·5	72·1	79·3	92 2
February ...	9·59	6	10	3	2	1	22	...	84·3	73 1	78·7	88 8
March ...	21 60	2	9	5	6	1	23	...	85·1	73·2	79·1	92·4
Totals	46 62	10	26	11	12	4	63		...	...	...	..
Means	...	...	...	...	...	...	...	...	85·3	72·8	79·0	91 1
Hosororo, North West District												
January ...	11·43	4	15	2	3	1	25	...	85·3	69·9	77·6	85·9
February ...	10·25	6	5	4	...	2	17	..	84·7	70·9	77·8	85·7
March ...	14·03	4	9	5	2	2	22	...	84·8	70·0	77·4	84·7
Totals	35·71	14	29	11	5	5	64	...				
Means	...	...	...	...	...	...	...	...	84·9	70·3	77·6	85·4

CURRENT PRICES OF COLONIAL PRODUCE

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XXI, No. 5, Tuesday, 31st May, 1938.

SUGAR.

Per 100 lb. net 3 lb. per Bag allowed for tare

Dark Crystals for Local Consumption...$3.30
Yellow Crystals do. do. $4.00
White Crystals...$4.75
Molasses Sugar... ....none offering.

Above Prices include Excise Tax of 90c.

RUM.

Imperial Gallon. Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export)...60c.; Hhds. 52c., Barrels 77c
White, in Hogsheads—40 to 45 O.P...(for local consumption)..............45 to 55c

MOLASSES.

Per Imperial Gallon. Naked.

Yellow (firsts)..10c.
Yellow (seconds)...5½c.

RICE.

Rice.........per Bag of 180 lb. gross. Brown Super $4.00 to $4.25 ; No. 1, $3.75—$3.90 ; White, None available. Lower Grades $3.25—$3.65 as to quality
Padi..............per Bag of 143 lb. gross, $1.20 as to quality.

GENERAL.

Gold, Raw,..average per oz. $26 to $27.
Diamonds,—pro rata as to quality..........................average per carat $10 to $11.
Timber, Greenheart, (Lower grade measurements)...40c. to 60c. per c. ft.; for export 72c. to $1.00 per c. ft.
do. Railroad Sleepers—(Mora) ....$1.68 each.
Greenheart Lumber..$70 to $80 per 1,000 feet.
Crabwood Lumber..$60 to $75 per 1,000 feet.
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,.......................$4.50 to $6.00 per M.
Charcoal, Capped for shipment.......................................72c. to 85c. per bag.
Firewood...$2.50 per ton.
Coconuts...Selects, $9.00, culls $6.00 per M...Copra $2.00 per 100 lbs. prime Copra.
Balata........................Venezuelan, none. Local Sheet...36c. to 38c. per lb.
Cocoa...19c. to 19½c. „ „
Coffee..4¾c. to 5c. „ „

N.B.—Duty Payable on value at time of Importation and rate of exchange on day of arrival.

Vol. IX, No. 3. September, 1938.

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GEORGETOWN, BRITISH GUIANA

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The
Agricultural Journal of British Guiana.
September, 1938.

EDITORIAL.

ECONOMIC STOCK-RAISING.

In a report on a visit to Palestine and the Trans-Jordan, the Agricultural Adviser to the Secretary of State for the Colonies pointed out that "the improvement of flocks........is unlikely to be permanent until attention is given to feeding, for it has now been recognised that the class of animals which a country possesses depends upon the class of feeding which is provided." This statement expresses concisely what is now accepted as a universal truth. It is being shown beyond question that the limiting factor to bigger and better livestock industries in British Guiana is the problem of cheap, balanced feeds. Thus, in the case of cattle in this Colony, the grazing in general is relatively poor and the pasturage is seldom regarded as a crop requiring drainage, cultivation, irrigation and the application of fertilisers; but the cattle-owner cannot be too severely censured for this since the land on which his cattle graze is seldom his. Most of the lands rented for pasturage are grazed on the communal basis, and there has thus been in consequence little inducement for the individual to undertake the necessary expenditure for fencing and paddocking. Without fences and paddocks good pastures become poor and poor pastures become poorer.

The significance of this pasturage problem in regard to the development of a cattle industry has been receiving much attention by the Department's Livestock and other Divisions; the feeding value of the Colony's herbage has been studied on the Government Stock Farm and elsewhere, and it has been found that for the most part our fodders are deficient in lime and phosphate, but, in individual cases, contain considerable quantities of these constituents; by judicious admixture nutritive and palatable feeds are being obtained. Some of the fodders used in these trials and giving promising results, include Demerara Primrose, Guinea grass, Para grass, Wynne grass, Guatemala grass, Horse Weed, Teosinte and *Indigofera endecaphylla.*

In an article in this number ("A Grade Dairy Herd"), are discussed the problems which are being faced in building up a dairy herd of good stock and maintaining satisfactory production in regard to quality and quantity. This herd has been run on a purely commercial basis and the passages on "Feeding-Stuffs" and "Pastures" will well repay attention.

The points, which thus far have been taken, are discussed both to show the dependence of our biggest livestock industry—cattle—on the supply of suitable feeds and to indicate some of the steps which are being taken to achieve improvement; but it is not only in the cattle industry that feeds play this dominating part. The same holds good for poultry, and in this industry much importance is attached to this aspect; thus, when recently a series of meetings was held to consider the organising of a bigger local poultry industry, the case for balanced rations at cheaper prices was given an early hearing. At one of these meetings, convened by the Director of Agriculture on September 5, the chief item discussed was the formation of a Poultry Association together with the aims

and policy of such an Association. Now that the air is clearing in respect to local agricultural industries, sugar, rice, livestock, and with the increased activities of Government in connection with importations of improved types, there is a growing trade in live poultry and eggs. Encouragement in this direction is being provided by recently improved steamer connections between Berbice ports and Trinidad so that shipments are now being made from Berbice and other ports of the Colony to that market. For these reasons it seemed desirable to organise an Association of some type which could, in collaboration with the Department of Agriculture, exercise a watching brief over the industry, consider its needs, and undertake measures calculated to be of benefit to the movement generally.

It is accepted that, because of a number of factors such as the high cost of feed, the low prices of eggs and poultry, and the absence of an outlet for surplus production, poultry activities have in the past been somewhat fitful. Of these factors the most important is the absence of a locally produced and sufficiently cheap, balanced ration. Progress has, however, been made within recent years since it is now possible to import into the Colony, free of duty, certain feeds high in protein content. It is understood that the Demerara Meat Company which slaughters a good deal of the stock for consumption in Georgetown has in process of erection equipment suitable for turning out a cheap ration high in animal protein and processed from blood and animal refuse. Feeds of the starchy type can be obtained in abundance locally; coconut by-products can be useful. In a country such as British Guiana, where rice is extensively grown, it would appear reasonable that by-products from this crop should be available to form the basis of a good ration. Up to the present, however, the rice milling systems which are in operation have, in general, found it difficult or impossible to recover the valuable rice by-products (*e.g.*, rice bran, etc.,) and to make them available for animal consumption. Plans are now under consideration for the establishment of modern rice milling units. Apart from the direct benefit to the rice producers, centralized up-to-date mills will be able to separate by-products which will then be available in such quantity and quality as to make the outlook for all forms of stock more favourable.

Another aspect of the feeding question will be a more general cultivation of peas and beans for use in poultry feeds; these are rich in proteins and although farmers have in recent years undertaken the cultivation of blackeye peas on a much more extensive scale, much can yet be done. Appreciation of the fact by farmers that peas and beans might, in addition to cash sales, be converted into poultry and eggs and sold as such, should serve as a further inducement for the inclusion of more of these crops in the regular farming routine.

An important factor which should be considered by those going into poultry-keeping as a business is whether or not the size of the enterprise embarked upon is large enough. Work done in many poultry-rearing districts has consistently shown that an influence of considerable importance in determining profit or loss in the poultry business is whether or not the minimum number of birds is being kept. When the number of birds kept is too small, the cost of supervision, feed, and sanitation make profits difficult if not impossible.

With a better outlook for feeds and with the organisation of an active poultry association, the possibilities are brighter for building up poultry-rearing into a minor but promising industry.

ORIGINAL ARTICLES.

MALARIA IN BRITISH GUIANA.

PART II. WHICH OF THE LOCAL ANOPHELINE SPECIES ARE RESPONSIBLE FOR THE TRANSMISSION OF MALARIA ?

BY

G. GIGLIOLI, M.D. (IT.), M.R.C.P., (LOND.); D.T.M. & H. (ENG.).
Medical Adviser to the Sugar Estates of British Guiana.

We have seen that three species of *Anopheles*, *A. tarsimaculatus*, *A. albitarsis* and *A. darlingi*, exist in this Colony in large numbers and with a wide distribution.

All of these are known as malarial vectors in other regions of Tropical America: *A. tarsimaculatus* is a carrier in Panama and Trinidad: Kumm (1932) at Bahia, in Brazil, found *A. albitarsis* abundant in houses and 5.8% were infected with malaria; *A. darlingi* is now recognized as the principal and most dangerous carrier in Brazil, from the Atlantic to the Andes, throughout the Amazon basin and in Venezuela; more recently, it has been found in French Guiana.

All these three species are susceptible to infection when made to feed on suitable malaria patients. We have ourselves had no difficulty in producing such artificial infections. These experiments are by no means conclusive as incriminating evidence, as the conditions which are created in the laboratory do not necessarily subsist in nature.

In the present section we propose to lead what evidence we have been able to collect concerning the relative importance of each one of these mosquitoes in relation to the transmission of malaria in this Colony.

(I) GEOGRAPHICAL AND TOPOGRAPHICAL DISTRIBUTION OF MALARIA IN THE COLONY, AND ITS RELATION TO THE DISTRIBUTION OF THE VARIOUS ANOPHELINE SPECIES.

There is no part of the Colony, on the coast or in the interior, which can be said to be entirely free from malaria. Concerning the incidence and the distribution of this disease it is necessary to bear constantly in mind that malaria infection can remain latent for weeks and months. The infection may not become apparent till long after the patient has left the locality where he contracted it. We have known cases which suffered their first attack in Europe several months after leaving the Colony.

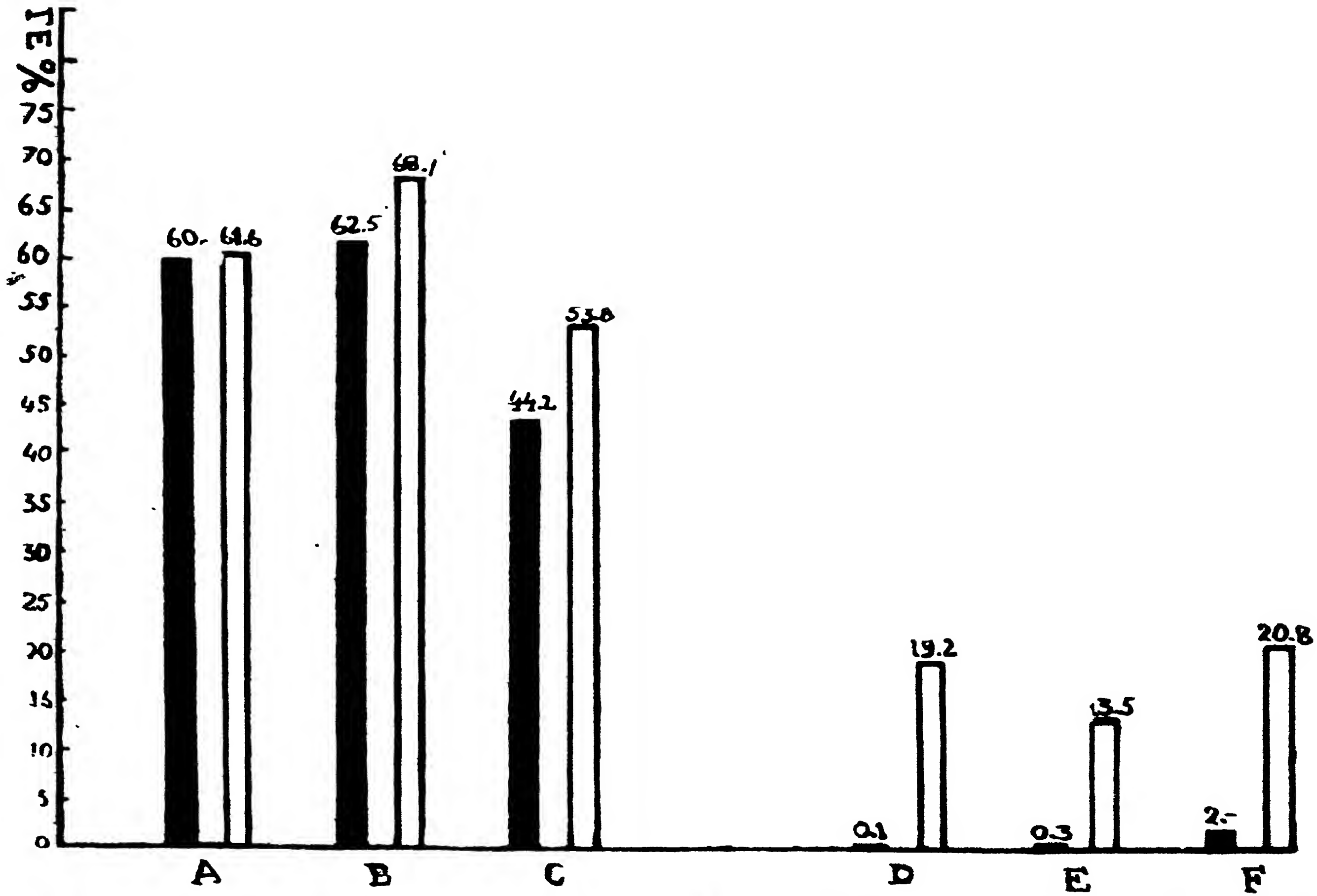

Fig. 1 :—The black columns indicate the Spleen and the white ones the Parasite Rates—By the comparison of these two values it is possible to "date" the existence of malaria in any one locality.

A, B and C refer to localities of the West and East Coasts of Demerara: the two rates are high and more or less similar; these localities are subject to endemic or habitual malaria. D, E and F refer to localities of the Corentyne Coast: while the spleen rates are nearly negligible, the parasite rates are considerable; this indicates recently introduced or epidemic malaria.

The occurrence of a few cases of malaria in any one given place, therefore, by no means implies that the disease was acquired on the spot and that the locality must be regarded as malarial.

In this connection the frequent displacement of the population from one district to the other, in search of work, must be considered. The gold, diamond, bauxite and timber industries keep a constant flow of men between the coast and the highly malarial districts of the interior. Cane cutting and rice planting and reaping again cause frequent seasonal displacements of the population along the coast and on the smaller rivers (Mahaica, Mahaicony, Abary and Canje).

Apart from these well defined, regular and, more or less, constant or seasonal currents, one must not forget the ordinary displacement due to business or pleasure as, for instance, the prevailing custom, amongst East Indian women and children in particular, of "passing time" with relations or friends on other estates or in villages.

We will now outline briefly the methods currently employed for measuring the incidence of malaria.

The *Parasite index* of a locality or community is given by the percentage of children, under 12 years, habitually residing in that locality, which actually harbour malaria parasites in their blood. This is a direct method of measurement giving exact data on the actual rate of infection at the time of the survey. Recent and acute infections naturally are the most easily detected.

The *Spleen index* shows the percentage of children which present enlargement of the spleen. This is a very frequent symptom of long standing and repeated malaria infection; other diseases may cause the spleen to enlarge, but in this Colony such conditions are so few and rare that their influence may be overlooked. The splenic index, being affected mainly by chronic and repeated infections, supplies information more particularly as to the *habitual incidence of malaria* in the locality.

It will be noted, therefore, that the Parasite and Spleen indices give somewhat different information; by their comparison we are enabled to *date* the local malarial outbreak and to decide whether we are in the presence of recent, epidemic or acute malaria or of old standing, habitual, endemic or hyperendemic malaria.

If malaria has only occurred recently, in epidemic form, many children will be found with parasites in their blood, but their spleen, in most cases, will be only slightly if at all affected. The parasite index, therefore, is relatively high whilst the spleen index, is low. Conversely if malaria has prevailed in the district for long years parasites and enlarged spleens will both be prevalent, and the spleen and parasite indices will, more or less, coincide. These points are well shown in diagram No. 1.

In the comparative study of spleen rates, in this Colony, it is very important to give full consideration to the racial factor. Negroes, though equally susceptible to malaria as other races, tolerate the infection better, and react less frequently and less conspicuously with splenic enlargement. In communities where Negroes abound the spleen index alone may give misleading results ; it should always be supplemented by the parasite index. Diagram No. 2 clearly illustrates this point.

Between 1933 and 1937 we carried out repeated malarial surveys at Blairmont and Providence on the Berbice River estuary, and at Bath on the West coast of Berbice. In 1937-38 we extended this survey to fifteen other estates from De Kinderen, on the West Coast of Demerara, to Skeldon on the Corentyne estuary. During the latter survey 5,814 children were examined for enlargement of the spleen and from 2,389 blood slides were taken for the demonstration of malaria parasites. Haemoglobin percentage estimations were also taken from each child, in order to determine the incidence and degree of anaemia.

These surveys have shown malaria to be endemic or even hyperendemic along the West and East Coasts of Demerara, and on the Demerara and Berbice river estuaries, with a tendency to become less prevalent on the coast as we proceed towards the east.

At Bath, on the West Coast of Berbice, locally acquired malaria is definitely uncommon. In our last survey in 1937, the spleen rate was only 1.3% and the parasite rate 3.5%. On the Corentyne Coast malaria, under normal climatic conditions, is even less common.

The last two years (1937 and 1938) have been definitely abnormal as regards malaria incidence. Between August and November, the disease prevailed in localities which are usually only mildly malarial ; malaria also became relatively common on the Corentyne Coast where, as a rule, it is absent.

Our survey, during this period, yielded some interesting figures :

At Albion, with a spleen rate of only 0.1% we found that 19.2% of children harboured malaria parasites (1937).

At Port Mourant the spleen rate was 0.3% and the parasite rate 13.5%.

At Skeldon 2% and 20.8% respectively.

These remarkable discrepancies between the spleen and parasite rates, as has already been stated, indicate that malaria is not endemic on the Corentyne Coast. Its relatively high incidence, in 1937, must be regarded as a purely epidemic and, therefore, transitory occurrence. We will return to this subject later when dealing with the seasonal incidence and local epidemiology of the disease.

In the settled areas of the interior, on the Demerara, Berbice, lower Essequebo, Pomeroon and other tidal rivers, malaria is endemic and, in many

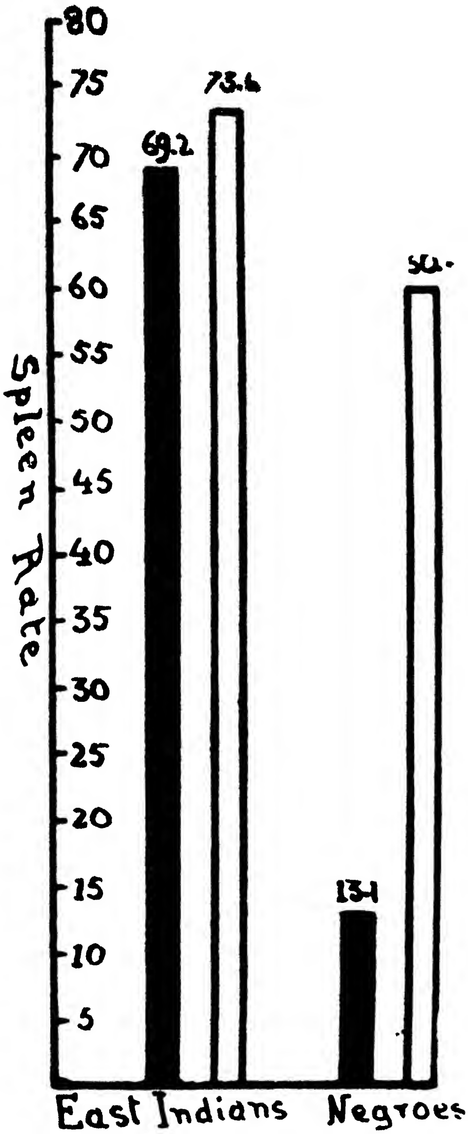

Fig. 2:—In the presence of chronic or repeated malaria infection the splenic reaction of the negro child is very much less marked than in the East Indian. This diagram illustrates conditions on an estate on the West Bank, Demerara; one notes that while there is clear similarity between the parasite rates of the two races, the negro spleen rate is less than ⅕ of that of the East Indians.

In negro communities, therefore, the spleen rate is of relatively little value; it should always be supplemented by the parasite rate.

localities, hyperendemic. Its occurrence in the upper reaches of these rivers is notorious; such localities as the Potaro district and Kurupukari, on the upper Essequebo, have particularly bad reputations. The Rupununi savannahs, formerly regarded as healthy, are reported to have suffered severely of late years.

This brief review confirms our previous statement that in the Colony malaria is ubiquitous, but its incidence varies within wide limits. Roughly we may say that this disease is hyperendemic or endemic throughout the permanently or temporarily settled areas of the interior; on the estuaries of the great rivers and on the West and East Coasts of Demerara.

On the front lands of the coast of Western Berbice it is very much less common; on the Corentyne Coast proper there is no endemic malaria, but epidemic outbreaks recur at intervals. On the wide estuary of the Corentyne malaria of late years, has been very mild, but during the last twelve months a severe exacerbation has been noted.

What correlation exists, if any, between this peculiar distribution of Malaria and that of the three prevailing Anopheline Species?

A. tarsimaculatus is only occasionally found in the forest areas of the interior, in localities from which the bush has been cleared. This low incidence is evidently and grossly disproportionate to the very high incidence of malaria in these districts. On the coast this species is abundant everywhere; we have found it particularly prevalent in mildly or non-malarial localities on the Western Berbice and Corentyne coasts.

A. albitarsis is eminently a savannah mosquito. We have not found it along the highly malarial tidal and flood rivers of the interior. It abounds throughout the East and West Coasts of Demerara, in pastures and rice fields; it occurs in exceptionally large numbers on the backdams of Western Berbice estates and on the Abary savannahs. It is very common at Bath where malaria is only very mildly endemic. So far we have few data concerning this species on the Corentyne Coast but we had no difficulty in finding it at Skeldon, where it is very prevalent in the cane cultivation aback. We have also found it in cow and sheep-sheds at Industry on the Corentyne front lands, some 12 miles East of New Amsterdam.

In our collection from the savannahs of the Rupununi this species accounts for $\frac{9}{10}$ of the specimens. The periodic occurrence of mosquitoes in myriads during and after the rains has always been a well known feature of these savannahs. Myers established that these mosquitoes were all Anopheles; but he failed to determine their specific identity. From these and our own findings we would conclude that during the wet season *A. albitarsis* is exceptionally abundant on the Rupununi, and that it was equally abundant a few years back, when the savannahs were regarded as free from indigenous malaria.

We are, therefore, led to conclude that the geographical distribution of *A. tarsimaculatus* and *A. albitarsis* in the Colony does not coincide with that of malaria. Both these species are rare or absent where malaria is at its worst and conversely they abound habitually where endemic malaria is low or even absent.

The geographical distribution of A. darlingi on the contrary coincides rigorously with the local distribution of malaria, moreover the incidence of malaria is directly proportionate to the incidence of this mosquito.

Where *A. darlingi* abounds malaria is hyperendemic; where it is found habitually but in smaller numbers or only at certain seasons, malaria is endemic and seasonal; where it occurs occasionally endemic malaria is absent but occasional epidemics follow in its train.

Of the three species of Anopheles we are investigating *A. darlingi* is the only one which is prevalent and wide-spread in the forest areas of the interior. It is very prevalent on the heavily infected river estuaries, and on the West and East Coasts of Demerara; it is, at present, very abundant on the West Bank of the Corentyne estuary where an epidemic of malaria appeared in August last year, and still persists.

This Anopheles is represented in our Rupununi collection. At Bath, in Western Berbice, where malaria is very mild, this species occurs but is rare. Of 669 Anopheles captured on this estate in 2 years, only 56 belong to this species. (1)

On the Corentyne coast *A. darlingi* is usually absent, but we found it present in small numbers at Port Mourant in October 1937, when a small epidemic outbreak was active. An epidemic is at present active at Albion; we visited this estate on the 5th of September, and found *A. darlingi* abundant in the houses.

Even on individual sugar estates, studying the incidence of *A. darlingi* in different yards and houses, in parallel with the malarial parasite and spleen rates, one is inevitably led to conclude that not only the geographical, but also the topographical distribution of this particular Anopheline species and that of malaria strictly coincide.

(1) In August this year, since the present section was written, an epidemic outbreak of Malaria of some severity has occurred at Bath. The spleen rate has risen from 1.5% in 1937 to 20% and the parasite rate from 3.5% to 69%.

A. darlingi has appeared in very large numbers and on the 19th of September, in one hour we captured no less than 460 specimens in the houses; 140 were caught in a single room of a range situated in close proximity of the cultivation.

Not a single *A tarsimaculatus* or *A. albitarsis* was found in the houses. in spite of the fact that the larvae of both these species were enormously abundant in all the surrounding irrigation canals, outnumbering those of *A. darlingi* many times over.

The causes of these unsual malarial outbreaks will be dealt with later under the Leading Epidemiology.

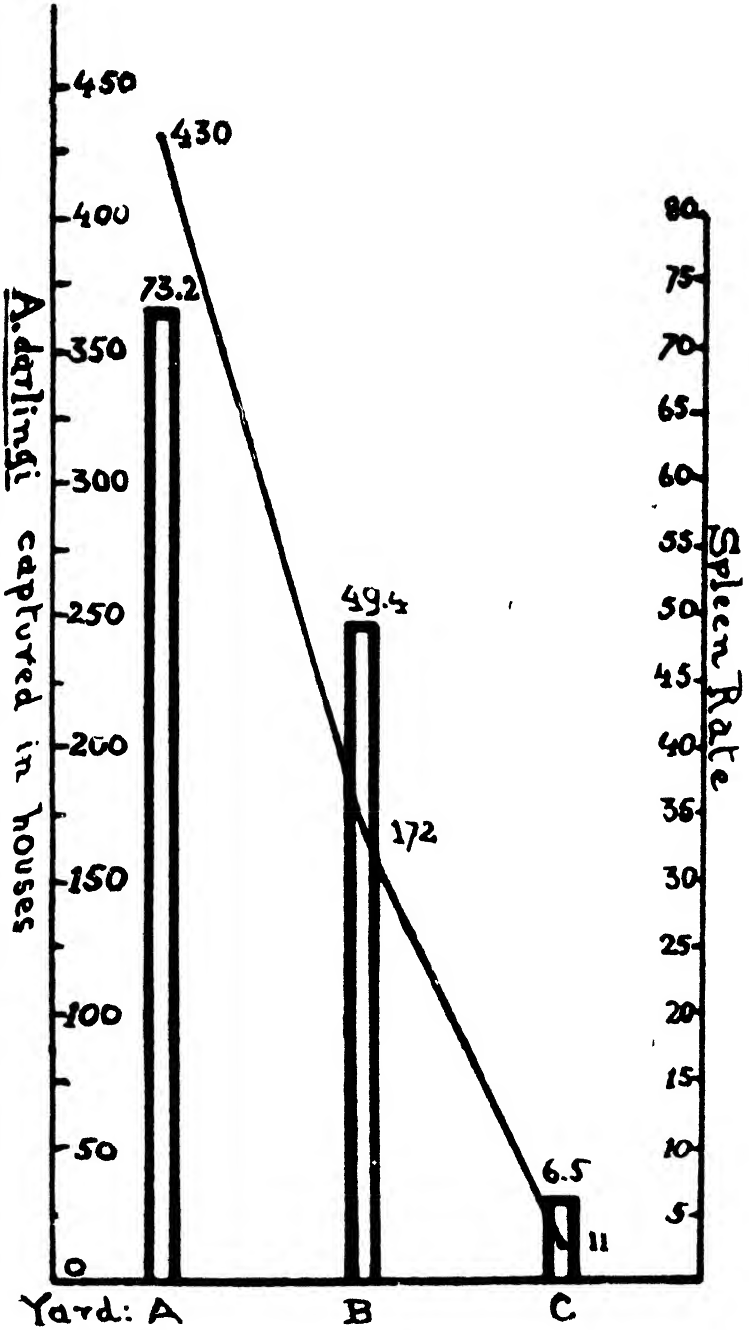

Fig. 3:—The correlation of the distribution of malaria and that of *A. darlingi* is not only geographical, but also topographical. This diagram refers to three separate villages belonging to the same East Coast estate, all situated within a radius of approximately 1 mile. The vertical columns indicate the spleen rate, and the curve the number of Anopheles captured by searching the houses for 2 hours in each locality. Of 613 Anopheles thus caught 611 were *A. darlingi*.

One of the estates, on the East Coast of Demerara, has its population distributed in 3 yards. In these the incidence of malaria varies within wide limits. On the 11th and 12th of August of this year, we carried out mosquito captures in the houses of these different yards, roughly the same time being devoted to each one.

In the following Table we correlate the number of *A. darlingi* captured to the spleen rate amongst the children in each yard:

TABLE I.

Yard:	Spleen Rate:	*A. darlingi* Captured:
Yard A	73.2	430
Yard B	49.4	172
Yard C	6.5	11

II. DOMESTICITY OF THE LOCAL ANOPHELINES.

The term "domestic" does not apply *sensu stricto*, to any of the local species of Anopheles, as none of these is in the habit of breeding in water collections or containers, pertaining to houses or their immediate surroundings (rain water tanks, vats and barrels, sagging gutters, discarded tins, etc.) In systematic inspections carried out during the last 15 years, we have *never* found anopheline larvae in such waters.

By "domesticity" we here mean to signify simply the *tendency of these mosquitoes to enter houses*. This is a point of very great practical importance, as it is an established fact that malaria is rarely contracted in the open.

In the following Table we give the relative incidence of *A. darlingi*, *A. tarsimaculatus* and *A. albitarsis* in a series of 15,035 Anopheles captured in houses on the Guiana Coast during the last 4 years.

TABLE II.

Locality.	Anopheles Captured.	RELATIVE INCIDENCE PER 100		
		A. darlingi.	*A. tarsimaculatus.*	*A. albitarsis*
Tuschen	503	99.8	0.2	0.–
De Kinderen	638	99.4	0.5	0.1
Uitvlugt	452	99.4	0.6	0.–
Wales	815	100.–	0.–	0.–
Ogle	120	99.2	0.–	0.8
Vryheid's Lust	366	98.6	0.3	1.1
La Bonne Intention	788	99.8	0.–	0.2
Blairmont	8,718	84.–	3.4	12.6
Providence	1,289	97.9	1.9	0.2
Skeldon	1,346	100.–	0.–	0.–
Total.	15,035	99.1	0.2	0.7

It will be noted that the domesticity of *A. tarsimaculatus* is consistently negligible throughout the coast; only at Blairmont *A. albitarsis* was captured with a certain frequency; this is due to the fact that the greater part of our captures, on this estate, were conducted in the village of Rampoor, which is situated 4 miles inland, on the edge of the Abary cattle savannahs where this mosquito is often extremely abundant. In this locality we found that whereas *A. darlingi* was constantly present in the houses, in more or less consistent numbers, according to season, *A. albitarsis* would be found fitfully, sometimes being absent, usually representing only 3 to 5 per cent., but occasionally as much as 15 to 25 per cent. of the Anophelines captured. In the open, in this locality *A. albitarsis* was always and by far the most abundant species from May to November.

In this same locality we also noted that the great majority of *A. albitarsis* captured in houses showed no evidence of having recently fed. This is well shown in the accompanying photographs.

Table 1 demonstrates that *A. darlingi* is very definitely attracted to houses; this is evidently not the case for either *A. tarsimaculatus* or *A. albitarsis*. The two latter species not rarely may be caught in estate hospitals or staff houses, where they are attracted, like myriads of other night flyers, by the bright electric lighting.

It might be argued that this different incidence in houses may simply be an expression of the different general incidence of the three species in the localities we have studied. This is certainly not the case, as *A. albitarsis* and *A. tarsimaculatus* could always be found in numbers, when searched for in their habitual haunts; moreover, the collection of larvae in surface waters (which was always carried out systematically and in parallel with the capture of adults) showed the larvae of these species to be constantly equally numerous, and often very much more so than those of *A. darlingi*.

III. Biting Habits.

A. darlingi is strictly a night flyer, becoming active soon after dusk. It undoubtedly bites man selectively.

We have investigated the incidence of the various Anopheles in animal shelters such as stables, cow and sheep pens. In many instances we have carried out captures on horses tethered in the open in close proximity to houses in which *A darlingi* was present in large numbers at the time.

PLATE I.

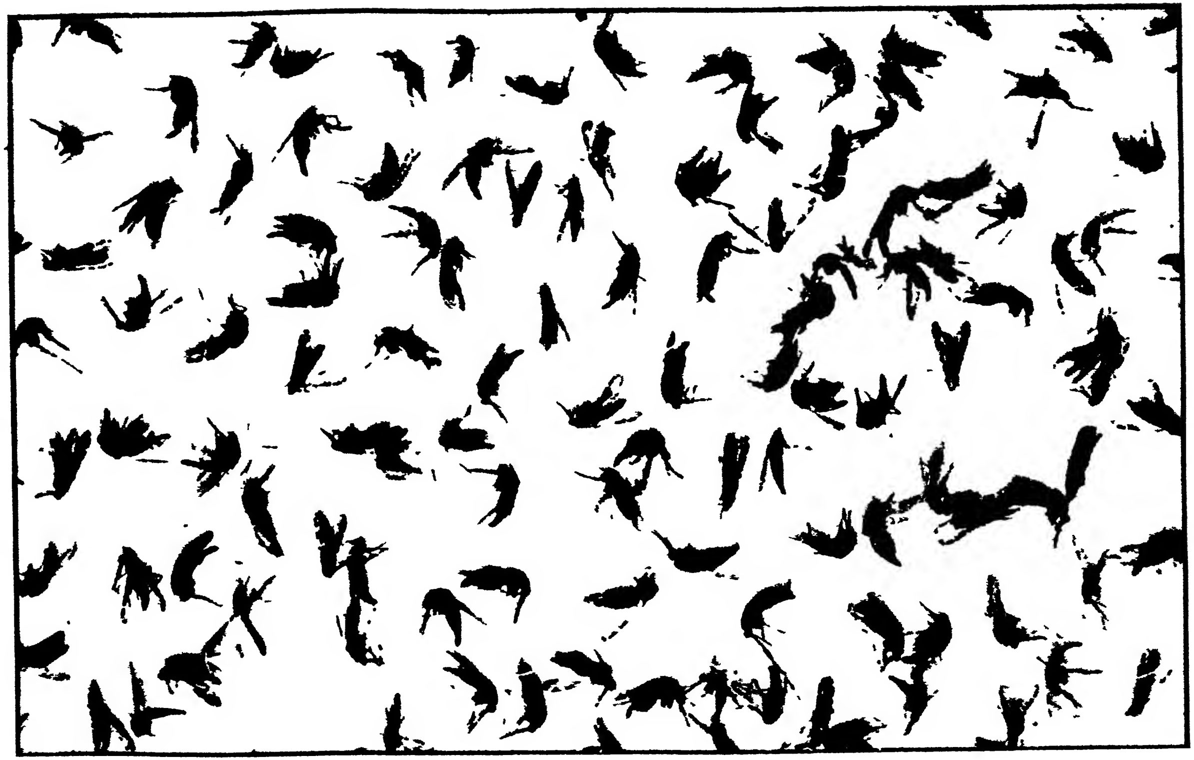

Fig. 4:—Random sample of *A. darlingi* captured in houses in the village of Rampoor (Blairmont) which is situated inland on the edge of the Abary Savannah. With very few exceptions all are gorged with blood. *A. darlingi* enters houses in large numbers and feeds on man selectively.

PLATE II.

Fig. 5 :—Random sample of *A. albitarsis* caught in houses in the same village. With very few exceptions none appear to have fed recently. *A. albitarsis* enters houses accidentally and feeds selectively on animals, cattle, horses and sheep in particular, both in shelters and in the open.

The following Table summarizes our findings :

TABLE II.

Locality.	Anopheles Captured	Relative Incidence per 100		
		A. darlingi	*A. tarsimaculatus.*	*A. albitasis*
De Kinderen	67	11.9	85.1	3.-
Uitvlugt	67	0.-	98.5	1.5
Wales	14	7.-	93.-	0.-
Blairmont, Bath, Providence	1,883	2.3	52.5	45.2
Skeldon	135	5.2	3.-	91.8
Industry (Corentyne Coast)	533	0.-	99.1	0.9
Total.	2,699	2.2	59.9	37.9

A. tarsimaculatus and, more especially, *A albitarsis* when disturbed from their resting places in close proximity to their breeding sites, will frequently attack by day even in full sunlight.

On the back dam of the Western Berbice estates and on the Abary savannahs *A. albitarsis* may be very troublesome even by day.

All our observations, in conclusion, tend to show that *A. darlingi* is definitely *anthropophilous* in its feeding habits, *i.e.*, it feeds on man selectively and, to this purpose, it enters and rests in houses in large numbers and, presumably, if conditions are favourable, it may fly considerable distances in search of its favourite meal.

A. tarsimaculatus and *A. albitarsis* are, on the contrary, strictly *zoophilous*, they feed selectively on animals ; for this reason their favourite haunts are animal shelters of various description.

IV. Conclusions.

Reviewing the data which have been presented in this and the previous section, we are led to the following conclusions :

(1) There are three species of Anopheles, in this Colony, which by their number and wide distribution must be regarded as possible vectors of malaria. These species are *A. tarsimaculatus*, *A. albitarsis*, and *A. darlingi*. The existence of the latter two species in this Colony was not previously known, both having been confused under the erroneous denomination of *A. argyritarsis*, a species which, though valid, we have failed to find in British Guiana.

(2) An investigation on the local geographical and topographical distribution of these three species of Anopheles reveals that the distribution and incidence of malaria is strictly parallel to the distribution and incidence of *A. darlingi*, a species which enters houses and feeds on man selectively. *A. tarsimaculatus* and *A. albitarsis* abound in localities which are habitually free from endemic malaria; when malarial epidemics occur we have always been able to demonstrate the presence of *A. darlingi*; the severity of such epidemics is directly proportionate to the incidence of this mosquito.

(3) *A. tarsimaculatus* and *A. albitarsis*, which abound on the pastures, sugar and rice plantations and on the savannahs of the Coast and far interior, bite animals selectively and cattle in particular. They enter stables and cow-sheds in search of food; human habitations only accidentally. *A. albitarsis* even when caught in houses rarely shows evidence of having fed on the occupants. The absence of endemic malaria in localities where only these two species abound, as at Bath and on the Corentyne Coast, is easily explained; these species, by feeding selectively on animals, are not liable to acquire and thereby, subsequently, transmit malarial infection.

(4) We have ourselves been able, without difficulty, to infect in the laboratory locally bred *A. tarsimaculatus* and *A. albitarsis* with local strains of malaria parasites, (*P. vivax*), but we are of opinion that the importance of both these species is negligible from a malariological standpoint: in order to be an effective carrier a mosquito must bite not once but repeatedly: it must feed, in the first place, on a human subject harbouring malaria parasites in a suitable phase; after an incubation period of at least 10 days the mosquito becomes infective, but, evidently, in order to transmit malaria again to one or more persons it must again feed on man, on one or more occasions. The figures and observations we have recorded which, we believe, are based on adequate material, were collected over an adequate field and for an adequate period, evidently show that both for *A. tarsimaculatus* and *A. albitarsis*, the likelihood of such repeated attacks on man by an individual mosquito is sufficiently remote or, at least, unusual to lose all practical importance.

(5). We, therefore, ultimately conclude that *A. darlingi* is the sole malarial vector of practical importance in this Colony.

(To be Continued).

COCONUT WILT IN ESSEQUIBO AND POMEROON DISTRICTS.

BY

D. W. DUTHIE, PH. D., F.I.C.

Chemist.

I. General.

Wilt disease of coconuts has existed for many years in the Caribbean area, and it has been the subject of several investigations. Follett-Smith (Ann. Rep. Chem. Div. 1930 p. 107) made one of the earlier investigations of the disease, but he found the evidence so conflicting that he made no definite statement, apart from noting that there was a higher content of available phosphate in the soil of healthy areas as compared with affected areas. Recently, Bain published the results of a long investigation of Trinidad Wilt (Bull. Dept. of Agric. Trinidad, 1937) and explained the disease as being due to the curtailment of root growth by a high water table at certain times of the year, followed by dry seasons which the restricted root system could not withstand. This explained the puzzling fact that trees grow normally for several years, as even a relatively small root system is sufficient to keep young trees in good health, but the strain of bearing is usually the critical point.

II. Coconut Wilt on the Essequibo Coast.

Field Observations.

Trees 15–25 years old are affected, and the symptoms are almost identical with those in Trinidad—the lower leaves show a characteristic bronzing at the tips, the nuts are shed, the remaining leaves wither, and finally the whole crown falls. A noteworthy feature is that, generally speaking, the disease moves in the direction of the prevailing wind.

The disease occurs both on clay and on sand, but the sandy areas are so small in proportion that they were omitted from the present investigation, as only limited time was available for field work.

Soil Sampling.

Top soil and subsoil samples (0–12 inches and 12–24 inches) were taken in three areas on Pln. Land of Plenty, viz:—

(a) A healthy bed in a heavy clay area (Field No. 1 Chinee Land)

(b) An adjacent bed in the same field, in which the trees were all affected.

(c) A field some distance away (Three Friends South, Cross Dam Field) of similar soil type, in which the trees had completely wilted about two years

before, since when the land had been covered with bush. It had recently been cleared for planting ground provisions.

Soil Analyses.

The complete analytical data are given in Table I.

TABLE I.

ANALYSES OF SOIL SAMPLES FROM PLN. LAND OF PLENTY, ESSEQUIBO COAST.

	Field No. 1 Chinee Land Healthy Bed		Field No. 1 Chinee Land Wilt Area		3 Friends Cross Dam Field Wilted, then in bush 2 years.	
	E 430	E 431	E 428	E 429	E 432	E 433
Depth	0—1 ft	1—2 ft.	0—1 ft.	1—2 ft.	0—1 ft.	1—2 ft.
Normal Reaction (pH)	4.9	5.0	4.7	4.9	4.9	4.8
Exchange Reaction (pH)	3.9	4.2	3.8	4.3	3.7	3.7
% sand	3.3	2.3	3.8	2.5	6.4	5.7
Index of Texture	37	40	38	38	35	33
% Soluble Salts	0.099	0.283	0.158	0.433	0.012	0.050
% Organic Matter	1.53	1.30	2.98	2.46	1.97	1.43
% Nitrogen	0.158	0.105	0.172	0.112	0.147	0.119
Carbon/Nitrogen ratio	5.6	7.2	10.1	12.9	8.0	6.9
Lime Rqt. Tons/acre 6"	6.0	3.7	8.0	4.4	8.3	7.4
Avail P_2O_5 p.p.m. Truog	nil	nil	nil	nil	nil	nil
Exchange & Water Sol. Bases Mg eqvs/100 gms CaO	3.33	2.35	3.05	3.44	2.18	2.02
MgO	5.36	11.05	8.65	12.65	4.51	7.72
K_2O	0.14	0.25	0.21	0.18	0.29	0.09
Na_2O	1.86	5.38	2.38	4.62	0.37	0.50

This soil may be described as an acid clay, markedly deficient in available potash and phosphate, but with adequate nitrogen and organic matter. It should be noted, however, that coconuts normally grow on poor soils, so it cannot be argued that potash and phosphate are the limiting factors. The significant figures are those for per cent. soluble salts and per cent. exchangeable magnesia and soda. They indicate that the Chinee Land field soil is suffering from lack of aeration and drainage, since there is an accumulation of saline substances in the subsoil. But this is not due to waterlogging, as the soil was quite dry at the time of sampling, even though there was standing water in the drains between the beds. Some attention was therefore focussed on the water relationships of this soil.

Soil Moisture.

The rainfall from 1st January to the date of sampling (24th March) was abnormally high : 11.6 inches fell in January, 6.25 inches in February and 13.11 inches from 1st to 24th March. Most of the drains contained water, but the soil in the centre of the beds was by no means sodden. An attempt was made to find the water table, but this could not be reached with a 2-ft. auger

even by boring *less than six inches away from a drain containing water.* Thus the percolation of both rain and drainage water is extremely small, and soil samples from the healthy bed in Chinee Land Field were taken in sealed tins (0–6", 6–12", 12–18" 18–24") for moisture determinations. Table II gives the detailed results, along with approximate figures for the Wilting Point of the soil, *i.e.*, that moisture content at which the plant is unable to overcome the attraction of the soil for water. These figures show that the soil had a gross moisture content of about 25 per cent., the danger point being about 13 per cent.

TABLE II.

SOIL MOISTURE RELATIONS OF HEALTHY COCONUT BED AT LAND OF PLENTY.

Depth	0—6"	6—12"	12—18"	18—24"
Gross moisture %	23.0	24.0	26.0	27.6
"Sticky Point" moisture % (P)	32.8	37.8	35.2	32.7
Sand %	3.3	3.3	2.3	2.3
Wilting Point moisture % [0.37 (P − 1/5 sand)]	12.0	13.8	13.0	12.0

Thus in spite of the heavy rainfall of the previous three weeks, the soil had only 12 per cent. available moisture, and in dry spells it would probably approach the danger point, which may be even higher than 13 per cent. on account of the comparatively high salt content of the soil (*i.e.*, magnesia and soda).

Root Distribution.

Further observations confirmed the suggestion that movement of water in the compact clay might be the key factor in the disease. Trenches were dug round two trees, one which had died about two years before, and one which was just beginning to wilt, and their root systems were examined. Approximately 50 per cent. of the roots were found in the top 6 inches, about 25 per cent. in the second 6 inches, and the remainder were sparsely distributed down to four feet. The roots tapered off rapidly from the base of the tree, and it was evident that they were not finding it easy to penetrate the stiff clay. A distinct colour change in the soil was noted at 15–18 inches from the surface, being the depth to which cultivation had been reached when the land was under sugar-cane.

Cause of the disease.

The roots of forest trees and bush penetrate into the soil as far as six feet even in a heavy clay, and thus aeration and drainage are maintained far below the surface. If the trees are cut down and another tree crop, such as coconuts, is planted, the young trees will have an opportunity of sending their roots

equally far into the soil. Changing from bush to coconuts does not cause any great change in the soil structure, and even on poor soils where this change has taken place, the coconuts have given good yields over many years.

The widespread cultivation of sugar-cane in this Colony led to large areas being changed from bush to sugar-cane—a shallow-rooted grass crop which exploits the top 18 inches of the soil and *leaves the lower layers free from roots.* The soil ecology was drastically altered, since the topsoil was intensively cultivated and the lower layers were allowed to become compact and "lifeless." On heavy clay lands the natural drainage was thus impeded and an elaborate drainage system had to be constructed in order to get rid of excess water as rapidly as possible.

When economic conditions led to the abandonment of many sugar estates, coconuts were planted on some of the old cane beds, and the young trees found themselves in a well-drained highly organic topsoil, which favoured their rapid growth. As the roots passed down from the cultivated layer, they found a saline, compact clay with little oxygen, and a limited water supply, and thus the greatest root development took place in the surface soil. A mass of roots developed near the surface which further hindered the penetration of water, and the added strain of bearing fruit left the trees undernourished and sickly.

The coconut tree is sufficiently hardy to withstand lack of soil nutrients, but a good water supply is essential, and in dry periods the soil on the windward side of a field would rapidly dry out and approach the "wilting point". If a few trees died, their shade would be removed, lack of moisture would affect the neighbouring trees, and wilt would gradually move in the direction of the prevailing wind.

It is significant that fields which appear to be waterlogged, overgrown with bush, and generally "neglected", do not show signs of wilt, and the natural reaction of the planter is to consider these good fields and to underbush and improve the drainage whenever the price of copra rises. By doing this he is aiding the rapid run-off of water, increasing the evaporation from the surface of the soil and possibly causing wilt to appear.

To sum up, wilt disease of coconuts on the heavy clay soils of the Essequibo Coast is probably caused by planting coconuts on old cane beds, where the subsoil is too compact and saline to allow easy root penetration, with the result that the topsoil becomes a mass of roots, and percolation of water is greatly hindered. The trees are thus living on the verge of drought, and "physiological drought" will also play an important part, owing to the high content of magnesia and soda even in the topsoil. When evaporation from the soil surface is increased by "clean-cultivation" or by the death of a few trees, wilt appears and spreads slowly in the direction of the prevailing wind.

Cure and Prevention.

It is clear that soil aeration and water penetration must be improved, but the thick roots of the coconut tree render inter-cultivation very difficult. It might be feasible to use a harrow, gradually going deeper and forcing the roots down, but this would not improve the subsoil, and it would be difficult to improve the condition of trees which are threatened with wilt. Planting windbreaks, encouragement of deep-rooted woody ground cover, and even flooding for short periods might ameliorate the condition to some extent, but the subsoil conditions would probably remain the same. Mr. S. H. Seymour of Pln. Affiance has suggested the use of dynamite to shatter the subsoil when it is dry, and this is worth trying, as it may even be economic on a fairly large scale. Oil geologists have recently used dynamite in conjunction with seismographs. in order to interpret the deep strata, and thus the effect might be more widespread than is generally supposed.

With regard to fields which are to be replanted with coconuts the procedure is straightforward. Flood-fallowing for long periods—over twelve months—would probably do much to improve the subsoil conditions, but the safest method would be to leave the land in bush for a few years before replanting. Table I gives the soil data for a field (Three Friends South, Cross Dam Field) in which the coconut trees had all wilted and the area had been left in bush for about 2 years. There is a marked difference in the subsoil from that of the Chinee Land Field, as the saline components had been partly removed. In this field the surface soil was much more friable than in the Chinee Land Field, and it is probable that a longer period in bush would improve it even more.

These arguments and considerations were the result of discussions in the field with the Deputy Director of Agriculture, the Agricultural Superintendent, Essequibo, Mr. S. H. Seymour (Pln. Affiance) and Mr. E. Taylor (Pln. Land of Plenty) and thanks are due to them for valuable information and suggestions. The soil analyses were carried out by the Assistant Chemist, Mr. C. L. C. Bourne.

III. COCONUT WILT ON THE POMEROON RIVER.

Several small areas on the banks of the Pomeroon River have been planted in coconuts, on soil which varies from deep pegasse to pegassy clay. The trees grow particularly well at first, come into bearing very early, sometimes when only three years old, but they wilt at about 10 years. An area which has been replanted after wilting will show equally good promise, but it may show signs of wilt after 7 or 8 years, and repeated planting appears to shorten the life of the trees to as little as 5 years. Generally speaking trees on the dams grow well, even on clay, and they may live for 20 to 30 years without showing signs of wilt.

Field observations showed that the conditions fitted Bain's explanation of wilt in Trinidad. In wet seasons the water table at high tide is 18 to 24 inches below the surface, the soil is well aerated and conditions are admirable for the

growth of trees while they are young. Root growth is limited by the high water table, and thus the trees die when their root systems develop beyond a point which depends on their height above the river. Cultivation and aeration of pegasse causes it to shrink rapidly, and thus the water table is nearer the surface when the field is replanted after wilting.

Dwarf Coconuts might survive longer under these conditions, but the most satisfactory remedy would be to plant coconuts only on land which is at least 6 feet above the water-level of the river at high tide, as proved by test borings.

A GRADE DAIRY HERD.

BY

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One of the principal objects for the establishment of this herd was to demonstrate that a good grade dairy herd could be made an economic success in British Guiana and also to provide reliable data on the various problems arising.

Intensive methods of production have been employed, as land carrying a dairy herd bears a high rental owing to the fact that it needs to be reasonably well drained and to have a reliable water supply throughout the dry season for the pasture.

The herd was started in 1929 with two cows, and by 1932 nine head were added. In 1933 it was put on a commercial basis, and from then to 1934, 11 head were purchased. Since then, no further additions to the herd by purchase have been made, as improvement was very disappointing and uniformity difficult to attain through animals whose ancestry was not known. In dairy herd improvement the only sound and economic breeding policy is to breed the best to the best, therefore only purebred bulls were used on the best cows, all low producing animals were weeded out, and the female calves raised for replacement. Thus improved production and uniformity were gradually attained.

The following Table shows the number and classification of the herd at half year ending June 30, 1938:—

TABLE I.

	Cows	Heifers	Bulls	Total
Purebred Guernseys	3	1	—	4
,, Holsteins	3	4	—	7
1st grade Holsteins	7	6	—	13
2nd ,, ,,	7	8	—	15
3rd ,, ,,	2	2	2	6
4th ,, ,,	—	2	1	3
	22	23	3	48

It will be seen from the foregoing table that all the Creole milch cows that had been originally purchased were disposed of, and the present herd are all of improved breeding.

The first cross heifers in milk that were not up to standard were sold at a good price, and there has been a steady demand by buyers for grade milch cows or heifers in calf. Unfortunately, the same cannot be said of grade bull calves, —cattle-owners seem disinclined to buy good grade bulls to improve their herd, although there has been an improvement in the sales of these this year.

Table No. II, is given from a productive point of view and shows the number of days cows have been milked and the quantity of milk obtained during each lactation.

TABLE. II.

Purebred				Creole		Grade Holstein.					
Guernsey		Holstein				1st Grade		2nd Grade		3rd Grade	
Days.	Lb. Milk.	Days.	Lb. Milk.	Days.	Lb. Milk.	Days.	Lb. Milk.	Days.	Lb. Milk.	Days.	Lb. Milk.
360	3,817	365	4,852	219	2,738	360	6,550	306	5,080	290	6,008
441	6,340	449	8,810	241	2,390	316	5,806	357	8,834	347	9,042
411	4,904	302	5,620	262	2,870	396	5,275	312	8,024		
360	6,847	360	6,602	293	3,302	293	5,239	314	5,452		
392	6,516	198	8,025	242	2,735	345	6,417	392	7,912		
380	7,028			254	3,543	254	6,112	415	10,063		
						106	6,652	287	8,203		

The highest daily yield of 41 pints milk was obtained this year from "Elsie," a purebred Holstein cow born in the Colony. In 31 days she produced 1,502 lb. milk and seems likely to complete her lactation with 12,000 lb. for the year. "Bessy 2nd," a second cross Holstein cow freshened with 36 pints milk per day and a total yield of 8,834 lb. milk in 357 days. "Mackie," another second cross Holstein cow, gave 34 pints milk per day and a total of 10,063 lb. in 415 days. There are also other grade cows that have given 36 pints daily, but have not yet completed their lactation. These yields are especially gratifying as the animals are under the usual routine of feeding and management.

MILK PRODUCTION.

The production of milk has continued to increase.

Table III shows the annual production.

TABLE III.

1933	...	12,028 pints
1934	...	28,862 ,,
1935	...	35,083 ,,
1936	...	50,980 ,,
1937	...	59,005 ,,
1938 (8 months)		50,000 ,,

The work of grading up the herd with purebred Holstein bulls has been carried on; the young animals of the fourth cross are showing the characteristics of the purebred Holstein.

Table IV shows the pedigree of Bessy 4th, a fourth cross Holstein heifer

TABLE IV.

Bessy 4th
- Sire — Demerara Kerk
- Dam — Bessy 3rd.
  - Sire — Sir Rocham Kerk
  - Dam — Bessy 2nd
    - Sire — Pontiac Jewel de Kol.
    - Dam — Bessy 1st
      - Sire — Texas Wonder
      - Dam — Creole Cow.

There are only two crosses more to attain the top grade which is considered purebred, but is not eligible for registration in the herd book of the breed.

Table V clearly shows how the grade blood disappears:—

TABLE V.

Generations.	Sire's % of purity.	Dam's % of purity.	Offspring's % of purity.	Percentage of unimproved blood.
1st cross	100	0	50	50
2nd „	100	50	75	25
3rd „	100	75	87.5	12.5
4th „	100	87.5	93.75	6.25
5th „	100	93.75	96.87	3.12
6th „	100	96.87	98.44	1.56

Grading up is the cheapest and most economical method of herd improvement. The following table showing production and net income of Holstein grades and Creoles under similar conditions serves to indicate the important part that a purebred sire plays in improving the herd.

TABLE VI.

Breed	Lactation Period	Total Yield	Milk fed to calf	Milk sold	Net Income
		lb.	lb.	lb.	
Creole	4th	3,302	1,558	1,774	19.88
„	5th	2,738	1,556	1,172	5.19
„	6th	3,543	1,734	1,809	25.80
„	4th	2,738	1,650	1,088	4.49
„	5th	2,330	1,526	864	− 5.52 Loss
„	6th	2,807	1,614	1,193	3.44
Holstein 1st Cross	4th	6,014	1,806	4,208	108.98
	5th	6,222	1,798	4,424	108.32
„	6th	6,470	1,780	4,690	122 83
Holstein 2nd Cross	1st	5,260	1,770	3,490	81.47
	2nd	9,712	1,770	6,142	164.35

The above shows that the Creole cow even when carefully selected has no place in economical dairying. The lactation period is too short, only about eight months, while the Holstein grade will milk for a year or more. The comparison was made over a period of 3 years and all the animals came into lactation within a few weeks of each other, so that seasonal conditions were practically the same for each trial. All the Creole animals were disposed of after this experiment.

Fig. 1 :—"Orchard Leigh Heilborn Mercedes." A pureberd Holstein-Friesian Bull owned by the Department of Agriculture.

Fig. 2 :—"Candies Carbine." A purebred Guernsey Bull owned by the Department of Agriculture.

PLATE IV.

Fig. 3:—A Grade Holstein-Creole. Herd.

Fig. 4:—Grade Holstein-Creole Calves, 10—12 months old, reared on a commercial calf meal feed.

Calves are allowed to suckle their dam 24-36 hours after birth to obtain the colostrum. They are then removed from their dam and fed milk from a pail until weaned at 6 months of age. For the first two weeks of life, the young calf is fed 6 pints of milk daily divided into three feeds. Thereafter the milk is increased to 8 pints daily, and is given in two feedings. After the third week, concentrates and grass are fed in addition to milk, the concentrates being increased gradually every month so that by the 5th month the calf is getting 4—5 lb. daily and all the grass it will eat. Clean drinking water is available at all times ; this is an important detail that should not be neglected ; calves fed under this method are thrifty and well grown when weaned. The cost of feeding whole milk from birth to weaning is however, rather high, averaging about $70 as the following table shows :—

TABLE VII.

Months.	Weights.	Total Feeds.	Daily Gain.	Cost per month.
	lb.	lb.	lb.	$
1st month	65 birth weight 110	Milk 279 Grain 12	1 47	10.46
2nd month	165	Milk 252 Grain 15	1.89	9.88
3rd month	210	Milk 304 Grain 78	1 45	12.56
4th month	240	Milk 300 Grain 90	1 00	13.05
5th month	310	Milk 310 Grain 124	2.26	14.00
6th month	340	Milk 192 Grain 159	1.00	10 00
				$69.95

Calves were reared somewhat cheaper this year than formerly, by feeding a limited amount of whole milk and then substituting gradually an imported calf meal. Unfortunately the calf meal was finished during the 5th month so that the experiment could not be carried out for the full period, as the meal could not be obtained locally. The growth and condition of the calves were quite good and the average cost was $38 per calf. This large saving in the cost of rearing calves should be of great help to local dairymen.

After calves were weaned they were put on to good pasture, and all grain feeding discontinued. It was noticed that up to about the sixteenth month of age growth had practically ceased but condition was maintained. After the sixteenth month, however, the rate of growth increased rapidly and good gains were made. Calves fed grain up to about the 14th to 16th month were put on good pasture; no appreciable setback occurred in the rate of growth and gains were good.

Why growth should almost cease from weaning to the sixteenth month seems to be explained by the fact that the digestive system of the weanling is not able to assimilate the nutrients in grass necessary for growth as the digestive system of the older animal is able to do.

In order to obtain accurate information as to normal growth, monthly weights and measurements for height were made on 12 calves as Table VIII shows.

TABLE VIII.

Age in Months	Height at Withers, Inches.	Weight lb.
Birth	28	73
1	29.5	110
2	31.5	142
3	32.7	184
4	34	210
5	36	260
6	37	296
7	38.2	320
8	39.5	356
9	40.5	394
10	41.5	421
11	42	442
12	43	473

It is intended to keep on with this experiment until the animals are 24 months old, should weighing facilities be available.

The following is the weight of two animals that were put on pasture at 8 months of age and have since received no grain.

	Height	*Weight*
14th month	41.5	389
15th month	42.2	396

Many of the dairymen of this colony do not feed their calves adequately. The allowance of milk is too small for growth and after the weaning period very little grain is fed. Therefore many of these animals are not big enough to be

bred until they are over 3 years, and do not come into production until they are 4 years and over.

Heifers that are well grown are bred at 18 to 20 months old. In order to maintain growth and development it is necessary to feed concentrates during the gestation period.

FEEDING STUFFS.

The feeding of grain is one of the most expensive items of expenditure. The continued rise in the price of local foodstuffs and the uncertainty of obtaining regular supplies were two of the most disturbing factors throughout the year, thereby increasing the cost of production. The margin between the cost of production and the selling price of milk is so small that when foodstuff prices increase above the small seasonal fluctuation, it tends to disappear very quickly and a loss occurs.

The value of a feed is largely determined by its composition and palatability. If deficient rations are fed the milk supply will drop, consequently some dairymen do not get as good yields of milk because of poor feeding.

Rice bran, broken rice and coconut meal are the principal concentrates used, but require a high protein feed such as linseed meal, soya bean meal or cotton-seed meal to balance the ration.

Molasses is a good feed as it helps to make the food more palatable and reduces the cost of the ration.

The following ration has been used with good results.

Rice bran	100 lb.
Coconut meal	50 „
Soya bean meal	20 „
Linseed meal	10 „
Molasses	20 „
Bone meal	4 „
Salt	2 „

The amount of the above ration fed to a cow in milk is 3-4 lb. for every gallon of milk produced.

Bone meal has always been included in the ration as the grasses are somewhat low in mineral content, chiefly lime and phosphorous.

PASTURE. (26 acres).

This has been the second year of pasture improvement and it serves to demonstrate the value of rotational grazing on improved grasslands.

When the pasture was first leased it was of a very poor type consisting chiefly of a tough wiry sedge, black sage and a few varieties of grass. It had to be completely fenced and was subdivided into paddocks. The sedge and sage were cut and burnt and part of the area was ploughed and planted with Para-

grass, Indigofera and Demerara Primrose. Only one paddock was manured with 140 cartloads of barnyard manure as the rainy season commenced and stopped the work. When the pasture was ready for grazing the cattle were turned on and allowed to graze the paddocks in rotation as Table IX shows.

TABLE IX.

Paddocks	Head cattle.	Grazing days continuously
No. 1	9	From Feb. 19 to Apr. 18—60 days
	12	„ June 7 to Aug. 6—60 „
No. 2	14	From Aug. 24 to Sep. 13—21 days
	12	„ Dec. 1 to Dec. 24—24 „
No. 3	9	From Apr. 19 to June 10—21 days
	10	„ Sep. 14 to Oct. 31—48 „
No. 4	15	From Aug. 7 to Aug. 19—13 days
	10	„ Nov. 1 to Nov. 13—13 „

The animals were in good condition and did well on pasture but were not grain fed as they were dry cows and young heifers.

Water was taken in during the dry weather to irrigate the grass and keep it growing; so that 2,040 lb. grass was cut and cured as hay and fed when grass was scarce.

The response of the pasture to management is manifested in the marked increase in the variety of grasses and in indigenous legumes thus increasing its nutritive value and its carrying capacity.

To improve pasture one must be assured of reasonable drainage and a water supply for the dry months. These two essential requisites indicate that such land must bear a fairly high rental and thus only improved stock of high production could pay for its improvement. If dairying is to expand and become an industry these facts must be considered and the general principles of live stock management be applied.

DISEASES.

The general health of the herd has been quite good.

Tuberculosis.

The intradermal Tuberculin test was done for the detection of tuberculosis, but no animals reacted to the test thus indicating that the herd is free from infection. Yearly tests will be made in future as a routine measure.

Mastitis.

There was one very acute case that resulted in the loss of one of the quarters of the udder. There were three other mild cases occurring soon after

parturition, of cows with large bags but these yielded readily to treatment. The fact, however, should not be forgotten that the higher the herd is graded up to heavier producing cows the greater will be the tendency to the occurrence of Mastitis. Cows must be milked with clean and dry hands, the udder kept clean and the animal well bedded so as to control as much as possible the external factors that contribute to diseases of the udder.

Breeding irregularities.

There was a marked improvement in getting the cows back in calf due in a large measure to having a stud bull on the farm instead of having to take the cows to the Government Stock Farm to be bred.

Sporadic abortion.

In the latter months of 1935 five cases of abortion occurred within a period of 2 months, and with cows in varying stages of gestation, at the 7th, 5th, 4th and 3rd months.

This increasing number of abortions occasioned a great deal of anxiety as it was feared that the bacilli of infectious abortion might have been introduced into the herd through a recent purchase of a purebred Holstein cow from a herd that had some breeding troubles.

The Agglutination tube test for infectious abortion was made. The titres used were a 1:25, 1:50 and 1:100 dilution. Known positive and negative sera were used as controls.

After 48 hours incubation at 37.5 degrees Centigrade the tubes under test did not show any agglutination thus indicating that the animals were free from infectious abortion. The positive antigen control tube showed complete agglutination in 1:100 dilution.

Strict hygienic measures were carried out and all aborting cows isolated from the herd and treated. They were subsequently rebred and have calved regularly without any further trouble, and no further cases have occurred in the herd.

Breeding troubles, if neglected, increase every year in a herd and cause a reduction in milk production and an increase in cost of production.

There is, however, a fairly high percentage of sterility cases among the milking herds on the coastlands and some work would need to be done to determine the causative factors and its prevention.

Table X shows the percentages of expenditure under their respective headings.

TABLE X.

Year	Wages	Feed	Pasture	Sundry Expenses	Buildings	Total
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1934	42.78	41.18	—	4.24	11.80	100
1935	40.41	48.89	—	7.49	3.21	100
1936	39.90	39.03	8.93	12.14	—	100
1937	34.83	40.30	7.86	11.53	5.48	100

It will be seen that in 1937 the benefits derived from the pasture show a reduction of the feed and wages bills, the two items of heaviest expenditure.

As the rainfall has an important bearing on dairying by keeping the grass growing over a longer or shorter period, daily records were kept for 1937. The rainfall for the year was 82.24 inches. The first 19 days of January 10.26 inches of rain fell and thereafter a short dry season occurred to April 18, with only 2.91 inches which caused a scarcity of grass. The mid-year rainy season commenced on April 19, to August 23, with a rainfall of 52.14 inches. During the wet period grass was abundant. During the second dry period August 24, to December 18, 8.07 inches of rain fell. This kept the grass growing until the middle of November when the weather became exceedingly hot and a scarcity of grass occurred.

SUMMARY AND CONCLUSIONS.

1. That it is possible to build up a profitable grade herd of dairy cattle by using purebred bulls on creole cows.

2. In milk yield the grade cow compares most favourably with the pure-bred, is hardier and more economical with feed.

3. The creole cow has no place in economical dairying.

4. The cost of rearing calves can be considerably reduced by feeding a limited amount of whole milk and substituting a calf meal.

5. The cost of local feed stuffs is high, and the supply not dependable.

6. That with the improvement of breed, there must also be an improvement of the food supply.

7. That with a reasonable amount of drainage, the coastal pastures can be improved by fencing, manuring and rotational grazing. The carrying capacity and nutritive value are increased and dairying can be considered an alternative to rice farming.

A MILLING TEST ON SIXTY PADI VARIETIES.

BY

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AND

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I. Method of Testing.

One difficulty in padi selection and breeding work is that a variety which is suitable from the point of view of cultivation *i.e.*, yield, lack of "shattering," strength of straw, etc., may give a high breakage percentage on parboiling and milling. A method was therefore developed by which small quantities of the different varieties could be tested under standard conditions of parboiling and milling.

Soaking and steaming were carried out by a laboratory adaptation of the method in general use in this Colony, and a high degree of efficiency was attained on account of the smallness of the samples (up to 300 grms.). The padi was placed in a conical flask, covered with water at 80°C (176°F), which immediately fell to 60°C when in contact with the padi. The flask, with a loose glass stopper, was left overnight (18 hours) in an electric oven, set at 60°C, which maintained the steeping water at 50—55°C (120—130°F.). A photograph of the steaming apparatus is given, showing how the steam is led from a copper boiler through a glass tube which nearly reaches the bottom of the inverted flask, the outlet for waste steam and condensation water leading downwards from the neck of the flask. The padi was steamed for 4 minutes, its temperature being about 100°C, as the steam was not under pressure. The steamed padi was dried in the sun, but considerable difficulty was experienced in standardising the temperature of drying. By a series of tests it was found that breakage due to rapid drying could be avoided by sun-drying under a muslin shade, thereby keeping the temperature of the padi below 38°C (100°F). Drying was continued until the padi had a moisture content of 12 or 13 per cent.

Milling was carried out in a small-scale machine manufactured by Messrs. Guidetti and Artioli, Vercelli, Italy, in which small samples of padi (*e.g.*, 100 grms.) can be hulled and polished in a manner which approximates to that in a large-scale mill. The machine consists of a carborundum disc huller, a carborundum cone polisher, and two fans by which the rice and hulls are blown from the huller to the polisher, and then are made to pass repeatedly through the polisher until a suitable finish is obtained. The machine is driven by a small electric

motor, and the air system also separates the hulls from the rice. The normal procedure is to hull, winnow and polish in one operation, the time required for 100 grms. of padi being 2—3 minutes, but these processes can be carried out separately, in order to find the breakage on hulling compared with that on polishing, and also to find the amount lost in polishing. The latter method was adopted in this investigation, the time of polishing being one minute. The broken grains were separated by the hand grader which forms part of the milling outfit. It consists of a metal plate, with hemispherical indentations of standard diameter (4.5 millimetres), suspended on wires and vibrated by an eccentric drive. The broken grains are retained by the plate, which is readily removed from its frame.

Conditions of steeping, steaming and drying were thus standardised as far as possible, although of course, the rate of drying varied with the amount of sunshine. "White-belly" was not found in any sample, so the method of parboiling was effective for all varieties. The parboiled padi was then hulled and winnowed, and the breakage due to hulling was measured. The whole grains were then polished for one minute, and the breakage and loss in weight due to polishing were found in the same way. Replications of the tests showed that fine distinctions of milling quality were not permissible, but the difference between the poorest and best was sufficiently large to show up those varieties which are likely to give a high breakage on large-scale milling. These differences would probably be magnified under factory conditions, since the lowest breakage percentages are small compared with those in commercial milling.

The test is thus of comparative value, and forms a useful adjunct to selection work. It is not suggested, however, that an otherwise promising variety should be discarded in the early stages of selection purely on account of its reaction to this test. By applying the test in the later stages of variety trials, when seasonal and environmental variations are being taken into account, it should be of value in judging a variety before large scale distribution is carried out. In addition to this, it might conceivably be used where strength of grain is being considered in breeding work.

II. Experimental.

The table of results gives the figures for breakage due to polishing, total breakage, length of grain (average of 10 grains husked by hand), and the yield in lb. from 1,000 plants in the selection tests. The varieties are arranged in three classes, long-grain types (over 7.3 mm.), medium-long types (6.9—7.3 mm.) and medium grain types (below 6.9 mm.). In each class the varieties are arranged in order of yield, since this property is the first consideration in selection work. Sethi *et al.* (Indian J. Agr. Sci. Oct. 1937 p. 713) carried out milling tests on six varieties of Indian padi, using 30 lb. samples milled with an Engleberg huller, and they attributed their differences in milling quality to seasonal factors existing at the time the respective crops matured, and to the post-harvest operations, such as drying, threshing, etc. In the present investiga-

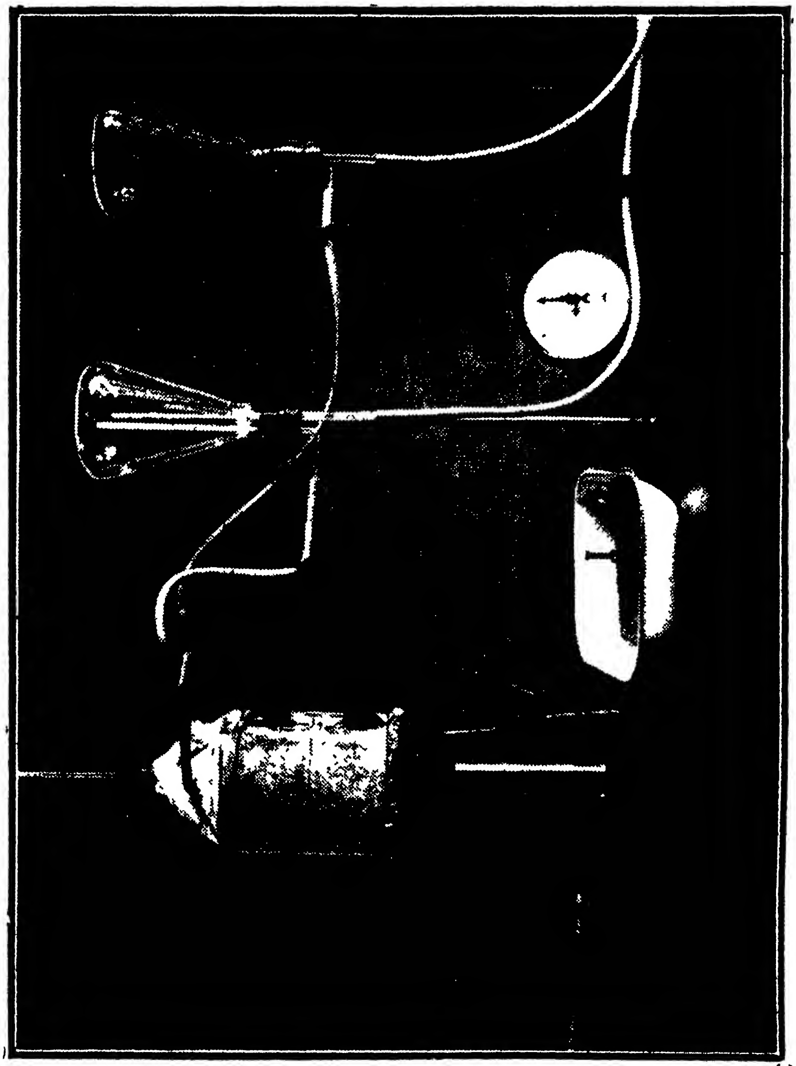

FIG. 1:—Apparatus for Steaming Padi.

tion these factors have been standardised to a great extent, since the plants were grown, harvested, threshed and dried under the controlled conditions of selection work. The breakages given by Sethi and his colleagues are high in comparison with ours, ranging from 37 to 55 per cent., due in part to the fact that they worked on a semi-large scale, with padi grown under field conditions.

Figures for loss of weight on polishing are not given in the table, as there was very little difference between varieties, the range of figures being between 10 and 12 per cent. This shows, however, that there is an appreciable loss of weight on polishing, and the breakage figures demonstrate that nearly all the breakage occurs during polishing.

TABLE OF RESULTS.

Variety	Yield: lb. per 1,000 plants	Length of Grain mm.	Total Breakage %	Breakage on Polishing %
Long Grain Types (over 7.3 mm.)				
54—37	110.3	7.7	8.5	7.4
Padi Berbice	100.7	7.4	12.2	11.1
Sue	95.6	7.4	4.7	4.3
Jaisingh	92.9	7.7	6.3	5.8
53—37	88.2	7.5	8.8	7.7
D 254	85.6	7.4	2.9	1.6
D 259	85.1	8.0	11.6	10.5
51—37	84.6	7.5	6.9	5.9
52—37	80.9	7.6	11.8	10.0
13—37	80.6	7.5	14.1	10.5
D 90	77.9	7.7	5.6	5.1
Seymour S	76.8	7.9	4.8	4.0
Nickerie Patna	75.4	7.4	6.3	5.5
D 89	71.9	7.6	6.8	6.1
D 162	69 4	7.4	5.6	5.1
D 221	67.6	7.7	5.7	3.9
31—37	67.5	7.4	11.1	9.0
30—37	65.1	7.5	5 3	4.3
Ramjess	64.6	7.4	3.4	2.6
D 228	63.7	7.8	9.5	7.8
D 91	63.6	7.5	6.3	5.5
Demerara Creole	61.1	7.6	4.2	3.5
27—37	57.1	7.5	8.8	7.6
No. 76	56.9	7.6	5.0	4.2
No. 75	54.7	7.5	5.3	4.7
Kalyaman	54.0	7.6	6.2	5.2
25—37	52.5	7.7	10.9	7.0

Average for Long-grain types : Total breakage=7.3 (Range 2.9—14.1)
Breakage on polishing=6.1 (Range 1.6—11.1)

Variety	Yield: lb. per 1,000 plants	Length of Grain mm.	Total Breakage %	Breakage on Polishing %
Medium-long Grain Types (6.9—7.3 mm.)				
D 255	110.2	7.0	3.6	3.1
D 256	92.9	6.9	3.5	3.0
D 115	86.3	7.1	5.3	5.2
D 253	84.2	7.3	7.3	5.3
D 258	82.2	6.9	6.0	4.2
D 116	73 6	7.1	6.3	5.1
D 109	73.4	7.3	8.1	7.1
29-37	72.1	7.3	6.4	5.0
D 92	70.6	7.2	7.0	5.9
D 251	70.5	7.3	3.4	2.8
D 114	68.9	7.1	5.6	5.1
D 88	63 7	7.3	7.5	6.7
H 7	61.2	7.3	7.1	5.5

Averages for Medium Long-grain types: Total breakage=5.9 (Range 3.5—7.5)
Breakage on polishing=4.9 (Range 2.8—7.1)

Variety	Yield: lb. per 1,000 plants	Length of Grain mm.	Total Breakage %	Breakage on Polishing %
Medium Grain Types (below 6.9 mm.)				
D 257	106 2	6.3	2.4	1.7
17-37	89.8	6.7	3.5	3.1
Unity	88.3	6.5	1.1	0.8
19-37	82.6	6.6	4.0	2.7
15-37	82.4	6.7	3.9	2.9
D 247	81.3	6.5	5.1	3.6
D 108	76.0	6.6	1.6	1.0
23-37	75.7	6.6	7.0	3.9
D 250	73.9	6.6	3.4	1.8
18-37	73.1	6.6	5.1	3.5
D 246	71.6	6.8	3.8	3.4
D 99	70.9	6.3	4.9	3.4
D 97B	69.7	6.6	3.7	2.2
D 94	69.6	6.6	2.6	2.2
D 193	69.1	6.8	3.1	1.7
D 110	68.5	6.8	2.0	1.7
Blue Stick	62.6	6.5	1.6	1.1
No. 79	61.6	6.5	1.2	0.7
D 261	54.1	6.3	3.6	3.1
D 262	45.5	6.6	4.2	3.9

Averages for Medium-grain types: Total breakage=3.4 (Range 1.1—7.0)
Breakage on polishing=2.4 (Range 0.7—3.9)

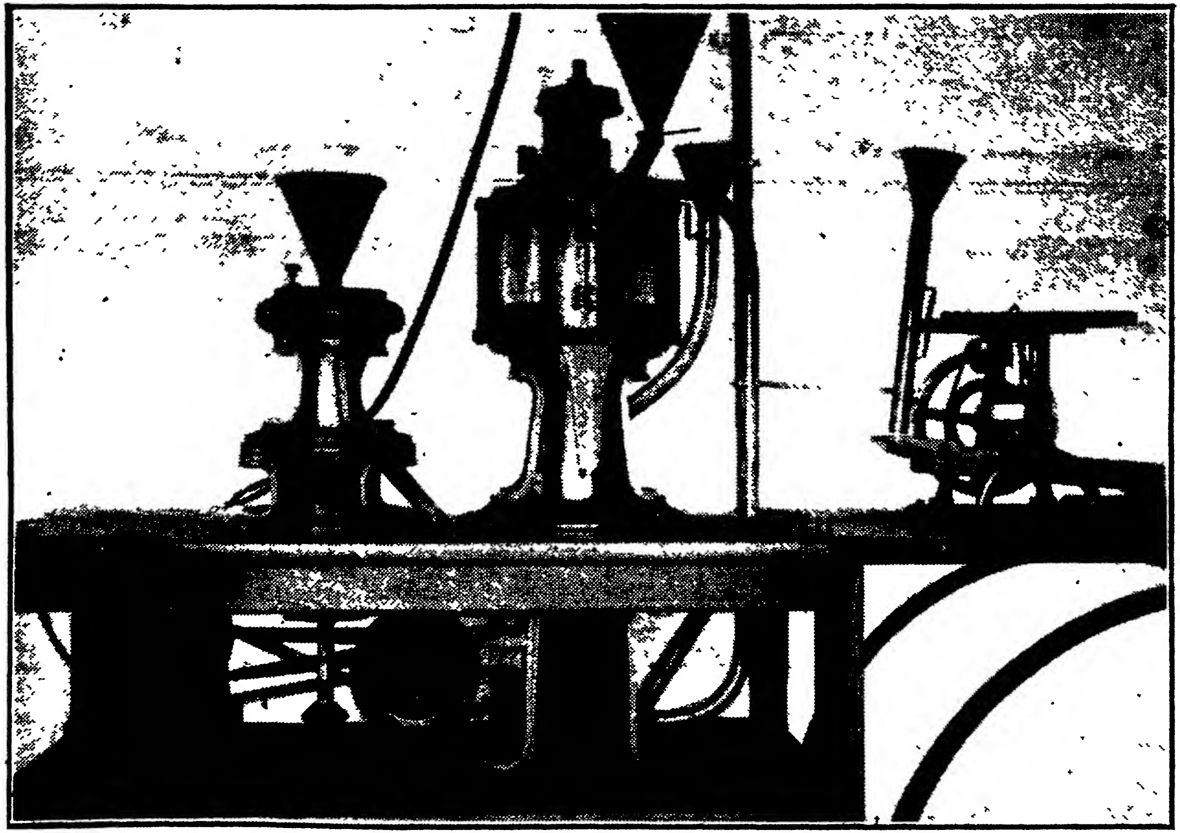

FIG 2:—Experimental Mill.

Left: Huller. *Centre:* Polisher. *Right:* Grader.

III. Discussion.

It is striking that about 90 per cent. of the breakage and a loss in weight of over 10 per cent. occur during polishing. This shows the value of pure line padi, since variation in size of grain and in colour of cuticle would probably make longer polishing necessary. On the other hand there were considerable differences between varieties in the colour of the unpolished rice grains, and thus it would be possible to cut down the time of polishing when working on a commercial scale with certain varieties. This point is important in the economics of rice milling, as it seriously affects both breakage and recovery.

As would be expected, the long-grain types gave on the average a higher breakage than medium-long, the medium grains being the best of the three classes. It is somewhat surprising to find that the shape of grain did not always prove to be a dominant factor, since Demerara Creole, a scimitar-shaped grain, gave a low breakage for its class.

Of the long-grain varieties, Sue, Seymour S, D 254, Ramjess and Demerara Creole appear to give the hardest grains on parboiling, but they are not markedly superior to several others, such as D 90, D 162, D 221, 30-37, No. 76 and No. 75, which show only a slightly higher breakage. It is difficult to pick out the best variety as regards milling properties, but several gave high breakages, which leads to considerable doubt as to their suitability for commercial extension. Of these, Padi Berbice, 13—37, D 259, 52—37 and 31—37 all gave over 10 per cent. breakage.

On the whole, there is not much to choose between the medium-long varieties. Even D 88, with 7.5 per cent. breakage, is not greatly inferior to D 251, which gave the lowest figure (3.4) of this class. Other varietal properties would probably assume more importance in the selection and breeding work in this class. The medium-grain padis, with an average breakage of 3.4 per cent. includes several varieties which repeatedly gave practically no breakage, since figures under 2 per cent. could be accounted for by bird damage and insect attack. From the miller's point of view, it would be preferable to concentrate on types with grain length below 6.9 mm., but of course, market requirements and other economic and biological factors might outweigh this consideration.

Undoubtedly, the most important factor in breakage is the rate of drying both in the field and on the factory drying floor. In our preliminary work we had considerable difficulty in ensuring that drying would take place at a reasonable rate without being too rapid. The effect of too rapid drying will far outbalance the differences between varieties which have been noted here, but it should be remembered that those varieties which showed up badly in this test, did so under conditions which were nearly ideal. It seems reasonable to argue, therefore, that varieties which gave comparatively high breakages would be difficult to handle under factory conditions, and thus the test would be of value in eliminating unsuitable varieties. On the other hand, it does not follow that every variety which is suitable on these standards will retain its place when

subjected to large-scale milling. In our first tests the rate of drying was too high for most varieties, but one or two seem to withstand even severe conditions, and further work along this line will be carried out in order to find which varieties can be dried rapidly without excessive breakage.

ACKNOWLEDGMENT.

This investigation was suggested by Capt. F. Burnett, Deputy Director of Agriculture, and thanks are due to him, and to Mr. P. A. Chan-Choong, Assistant Plant Breeder, for the padi samples and for the yield and grain-length figures.

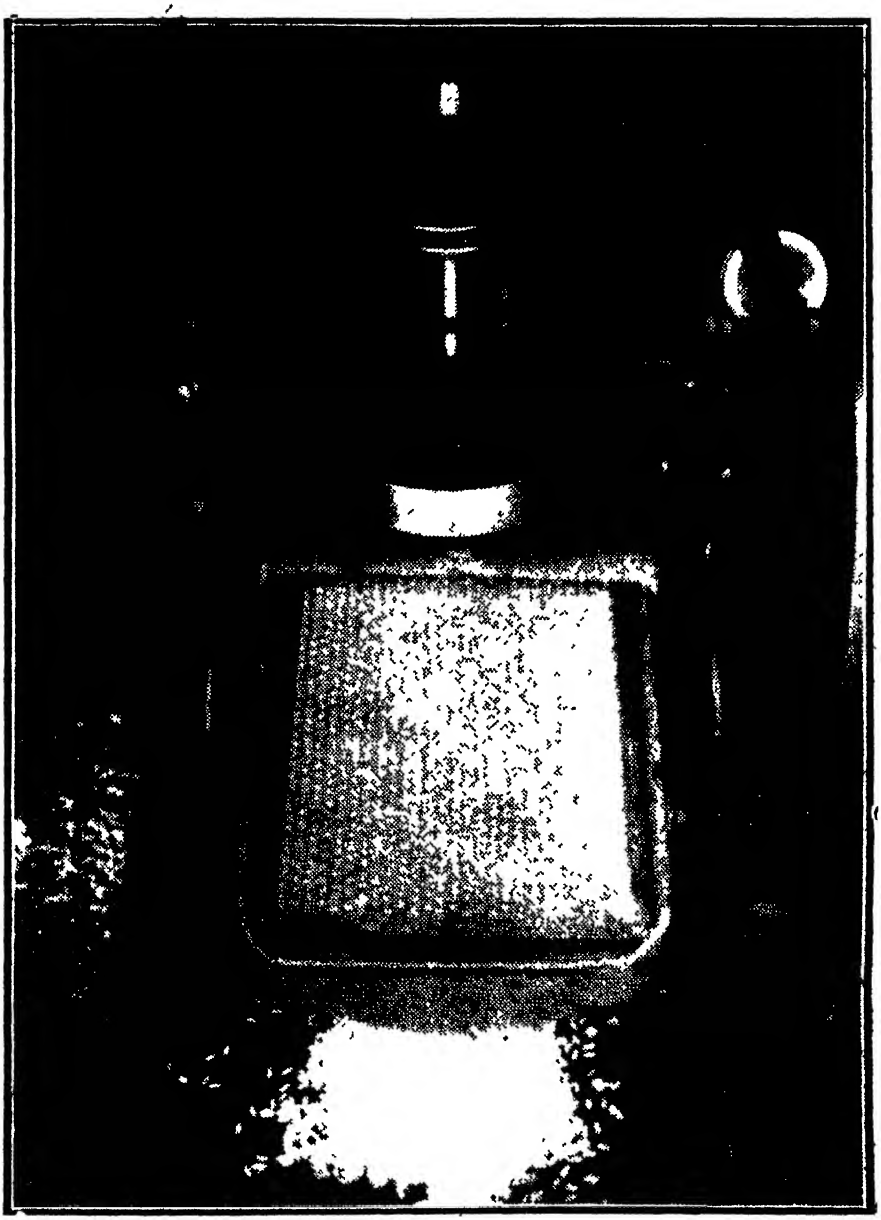

FIG. 3:—Close View of Grader.

SELECTED ARTICLE.

THE CULTIVATION OF CAJANUS CAJAN AND THE METHODS OF PREPARING MARKETABLE DHAL*.

BY

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Cajanus cajan (=*C. indicus*) is considered to be one of the most promising legumes at the present time. It is one of the favourite crops of the average village cultivator for a variety of reasons. The Indian farmer has recognized its value in the light of his accumulated experience extending over several centuries. The scientific study of agricultural problems during recent years has confirmed its recognition by the cultivator. It occupies a predominating position among the pulse crops of India and is used as a restorative, rotational or mixed crop.

From the point of view of keeping the soil in fertile condition in dry and arid tracts, there is hardly a leguminous crop that can stand comparison with it. Being a drought resistant crop, it grows successfully in tracts receiving annual rainfall of 25 to 30 inches or even less. It has been known to have grown successfully in some dry seasons when other crops have failed. It has a deeply penetrating root system which enables it to open up any hard set soil to a great depth thus aerating the soil and bringing it to a much finer state of physical condition for the subsequent crops. Throughout its growing period and particularly during the later stage it sheds a large amount of leafy material which definitely enriches the soil in valuable organic matter. Like other leguminous crops, it also fixes atmospheric nitrogen in the soil. From the economic point of view, the crop possesses some commendable features. The plant yields seed which affords a nutritious article of food. The leaves, the husk of pods and the seed coats, which are all by-products of the crop, are utilized as excellent feeding stuffs for the milch and draft cattle of the farmer. The stalks supply him his domestic requirements of fuel. The cultivator usually sells the surplus grain for which he finds a ready market. The crop has therefore many desirable features in its favour, *viz.*, it furnishes food for the farmer's family and cattle, provides fuel, and helps to maintain the fertility of the soil while it is also a money crop.

*Reprinted from the "Tropical Agriculturist" of Ceylon, Vol. XC, No. 4, April 1938.

The pulse is used in a variety of ways but its chief use is in its split form as *dhal.* Dhal contains as high as 18 to 20 per cent. proteins and is therefore of definite value to a vegetarian population. The tender pods of this crop are extensively used as a vegetable in the same manner as garden peas. An Indian cultivator living near a market sells the first part of his crop in the form of green vegetable pods and allows the pods which form later to mature for the production of seed.

The plant has further uses. During recent years it is being developed, particularly in the United States of America, as a leguminous fodder crop and in this respect is likely to rival lucerne in importance. It does not require such careful management as lucerne. Being a drought resistant and hardy crop it grows well in any soil under adverse conditions with little attention. It matures for fodder comparatively rapidly and is capable of being utilized as a perennial fodder crop. Live stock and poultry relish the crop. It has also been recommended as a green manure crop. According to leaflet No. 14 of the Ceylon Department of Agriculture it may be grown as a green manure crop interplanted with young rubber and coconuts in tracts receiving less than 100 inches rainfall. However, as a green manure crop for annual crops it does not compare favourably with other well known green manure crops on account of the comparatively slow habit of growth and the large proportion of woody material in the plant. It is also grown as a shade crop, cover crop, and occasionally a wind-break hedge plant. In Assam, for example, it is grown as a border crop round sugar cane fields more for the protection of the cane crop than for the yield of its seeds. In such cases the dry stalks serve the purpose of a much needed fuel in boiling the cane juice.

VARIETIES.

The plant is known to have a large number of varieties with slightly different characters, growing under varying conditions in many parts of India. The recent survey of the varieties of this plant by the Imperial Economic Botanist at Pusa (Scientific Reports of the Agricultural Research Institute, Pusa, 1928-29, page 21) shows that the number of distinct types obtained was 107 indicating great variations in height, habit of growth, the time of maturity, colour of flower, colour and shape of pods, and the size, colour and shape of seeds. The varieties, however, can be subdivided into main groups. The first comprises the perennial type which assumes a tree-like appearance and is allowed to grow for more than a year. From the point of view of yield of seed, this variety yields a fairly good first crop but the yield in subsequent years falls considerably. This type is used more as a shade, fodder, cover, or hedge plant than for seed. The small or annual type is mostly grown as a field crop for its seed. The size, shape and colour of seed vary in different varieties. The white seeded variety which is grown in Gujarat, Western India, yields a very fine quality of dhal fetching the best market price. The red or the brown seeded variety does not grow well in the heavy black cotton soils of Gujarat and is mostly confined to the lighter type of soils south of Bombay.

Soil and Climatic Requirements.

Cajanus cajan is grown mostly in mixture with a large variety of crops under a wide range of soil and climatic conditions. This fact indicates that the plant is quite capable of adapting itself to widely variable conditions. Under dry conditions it comes to maturity fairly quickly. Under humid conditions as would be expected the crop tends to produce luxuriant vegetative growth. Cloudy weather and rain at the flowering time causes defective fertilization and the pod-caterpillar appears on the crop damaging the growing pods. Stagnant water in fields is definitely harmful to the crop.

The wet zone of Ceylon is rather unsuited to the successful cultivation of this crop for seed production. The climate is likely to prove too humid and the flowering is liable to be affected. In the dry zones subject to one monsoon only and where the rain has almost ceased by the time the plants come into flower, the crop would naturally grow well. Moreover, there is every possibility of finding a strain suitable for any given local conditions from among the large number of varieties growing under a wide range of climatic conditions in India. If the aim is not the production of seed, the plant may be grown in the wet zone and will produce luxuriant vegetative growth for purposes of fodder, shade, cover, hedges or wind-breaks.

Methods of Cultivation.

In India the *Cajanus cajan* crop is usually grown as a mixed crop. It is sown in widely spaced lines as a subordinate mixture with other crop or crops of a shorter growing period, such as sorghum, maize, bulrush millet, other millets, gingelly, ground-nuts, &c. These intervening crops, being of a shorter duration than *Cajanus cajan*, are ready for harvesting first. The *Cajanus cajan* achieves its full growth after the maturity or removal of this intervening crop and is then able to utilize all the additional space made available between the rows.

Because of the fact that it is raised as a mixed crop, the soils available for this crop naturally vary with the requirements of its accompanying main crop. For example, with sorghum it will occupy a heavier clay loam type of soil; with millets, groundnut and gingelly it will occupy a lighter type of loam to sandy loam soils. Usually it does not require manures but if grown on a newly opened or well manured land, growth is luxuriant. As with any other leguminous crop the soil for this crop should not be deficient in lime. The character of preparatory tillage will be determined by the requirements of its associated crop. In India it is usually sown at the commencement of the south-west monsoon in June or early in July and is ready for harvesting by February or March. The other crops grown in association are usually harvested by the first week of October. The period from October to March is more or less dry and rainless. The crop does not require any irrigation during this long dry period because it is able to draw its own moisture requirements from lower depths with the help of its deeply penetrating root system.

In a common and typical form of mixture *Cajanus cajan* occupies every fourth row of the mixed crop which is either drilled by a special attachment to the country plough called *Mogan* or is dibbled behind the country plough in a line just opened by it. The *Cajanus cajan* will thus be in rows 4 to 6 feet apart depending upon the type of its associated crop and the spacing given to it. The seed rate with this type of mixture varies from 1½ to 3 lb. per acre. In the case of an unmixed Cajanus crop, the seed rate would amount to about 8 lb. per acre. In South India where it is sometimes grown mixed with groundnuts, the distance allowed between the two rows of *Cajanus cajan* is 10 to 25 feet. The object of keeping it so wide apart is to keep the groundnuts as far as possible free from shade. The seed rate in this case is naturally very low and depends upon the actual spacing.

After germination is completed the plants have to be thinned in the rows to a space of about a foot apart in light soils. In good and deep soils spacing may be done at 2 feet apart.

During the first 4 to 6 weeks, the crop shares the useful intercultivation given to the main crop. The crop is then usually allowed to take its own course. There is a belief in India that the more this crop is trampled when the main crop is harvested, the greater will be the subsequent development of branches, flowers and pods. When grown with groundnut in South India, the soil has to be dug over for removing the groundnut and this serves the purpose of a final cultivation without extra cost. If seed production is the object, the crop is allowed to remain standing in the field till the pods dry on the plants.

When it is used as a perennial crop, the branches are cut off for feeding cattle whenever required or at regular intervals. At the close of the season, the plants are pruned to about 2 feet above the ground. With the advent of the new season's rain, the pruned plants will start growing again. Thus the crop can be made to yield a large amount of leafy material in humid tracts for 3 to 5 years. It is, however, equally easy to renew the sowings every year.

HARVESTING AND THRESHING.

The crop is harvested by cutting the whole plant close to the ground by means of a sharp sickle. The actual treatment of the plants after they are cut depends upon the prevailing local conditions. Where there is risk of damage by rains or by thieves, the plants are tied into small bundles soon after they are cut and carted to the threshing floor. Bundles are then allowed to remain there for a few days till the green leaves left on the plants completely dry off and the ripe pods open slightly. If the possibility of damage by rain or by thieves does not arise, the harvested plants are collected and left in the field for a day or two till they are fairly dry and then carted to the threshing floor early in the morning to avoid shedding of seeds from the dry pods.

The threshing is usually done by vigorously shaking the dry plants. A good many pods and seeds with leaves are thrown out. Those that do not drop by shaking are finally beaten with strong bamboos or wooden flails. When everything has dropped from stalks the material is further beaten by sticks or trampled under the feet of bullocks which completely separates the grain. The grains are further cleaned from the chaff by subsequent winnowing. The chaff so separated is a good feeding stuff for draft cattle. The stocks are mostly used as a fuel. Thin or straight stalks or branches are used for roofing or for making the sides of the bullock carts.

Yields.

As a fourth row mixture, the yield of seed ranges from 300 to 600 lb. per acre depending on the type of mixture adopted and the soil and climatic conditions under which it is grown. A bushel of seed usually weighs 56 lb.

Method of Marketing in India.

The seed produced by village cultivators is usually brought by them in cart loads to primary markets located in small towns near by. Here the professional dhal-makers locally known as *golas* buy the produce with a view to making dhal out of it. This professional class of *golas* is found in most of the small towns all over India. To them dhal-making is a fairly profitable small scale industry extending over the greater part of the year. They are a class of people with limited means and work with the small hand-operated splitting mills run by hired labour. The methods of milling slightly vary in different districts. A few enterprising *golas* keep several such mills and work with a larger labour force during periods of demand. Large scale modern mills operated by mechanical power have not been erected to any appreciable extent chiefly because the people engaged in this industry are of limited means and also because most of the villagers are producers as well as consumers of dhal. A few power mills are to be seen in some large towns. Some of the cultivators who appreciate the value of home-made products make their dhal from their own farm produce. To them the necessity for selling the grain to *golas* and later buying the dhal from them does not exist. The dhal produced by the cultivators themselves is of good quality because of the great care exercised by them. Most of the dhal produced by the cultivator is for the use of his own family and only the small surplus is disposed of. As will be seen later, the process of dhal-making is quite simple, and every cultivator can prepare his requirement with little effort unless he has a more important call upon his time.

Preparation of Dhal.

The particular method of preparing dhal adopted has an important bearing upon the final quality of the commercial product. It may therefore be useful to discuss first the points which decide the quality of dhal. Dhal is chiefly used as a food in boiled form. A good quality of dhal should be easily

and quickly reduced by boiling to a homogenous semi-liquid mass. After boiling it should not continue to retain its original form or shape and should not show any unbroken hard pieces. If the dhal becomes soft in a reasonably short period of boiling, the flavour and taste of the cooked product is better than if boiled for a long time. This quality of softening after brief cooking should be retained during the storage period; this is the second important consideration of quality. Any sample of dhal, therefore, which cooks soft quickly and retains this quality during a fairly long period of storage is regarded as of good quality.

There are two well defined methods of preparing dhal in India. Each is practised under certain local conditions and has its own advantages and disadvantages.

The first is the *dry method* which is chiefly used in Gujarat and parts of Northern India. The dhal obtained by this method softens rapidly on cooking and the resulting flavour is very good. This method of preparation is costly and the proportion of broken dhal is comparatively more. The dhal obtained by this process is of perfect shape of a half-moon. It realizes a very good price in the market.

The second is the *wet method* in which water is freely made use of. Something like controlled malting takes place. The resulting dhal is hard to cook after a short period of storage and is not then fully reduced to a homogenous semi-liquid mass even after prolonged boiling. The flavour is not so good as in the dry method. The method has the advantage of cheapness. Another advantage in its favour is that the proportion of broken dhal is very small and therefore the percentage of dhal recovered by this process is much greater. The dhal obtained has a semi-round shape depressed in the centre. This process is extensively used in South India extending up to Bombay Deccan with slight local modifications.

Both processes require ample sunshine for thorough drying of the seed preparatory to dhal making. Therefore the availability of bright sunny days is the first important essential for successful dhal-making. Such conditions obtain in the dry zones of Ceylon and thus make possible the creation of a small village industry providing occupation throughout most of the year.

The splitting mill used in both of the above methods is a mill with two circular stones, one of which rotates round an axle fixed perpendicularly at the centre of the lower or bottom stone. The axle passes through the upper stone which is provided with a centre hole through which the grains are fed into the mill. There is another small hole near the circumference of this upper stone where a strong peg is fixed. By means of this peg the upper stone is made to rotate round the axle. The pulse seed is thereby split up into two halves or cotyledons and the seed coat is separated. The pulse seeds are fed through the

hole in the centre and the split dhal is collected below round the stone. The stone mill used in Gujarat generally weighs about 120 to 150 lb. and costs about Rs. 15 to 25 depending on the quality of stone used.

In some places a mill of larger size is used but has to be rotated by two persons working simultaneously. It is provided with two strong pegs fitted in two holes at opposite points on the upper stone near the circumference.

DRY METHOD OF MAKING DHAL.

This process can be conveniently divided into the following seven stages :—

(1) *Preliminary sun-drying.*—The seeds are exposed to hot sunshine for three to four days. If the temperature is below 90°F., drying may have to be prolonged for a longer period.

(2) *Preliminary and partial splitting of grains.*—This is usually done at noon. The grains are taken from the drying place and they are fed to the splitting stone mill in a hot condition. The grains are fed rapidly in large quantities at a time. The object is to get the seed coat pressed and effect some cracking of the seed coat while the seeds are moving in a hot condition between the stones. Along with cracking of the seed coat, about half the seeds split into cotyledons but their coats are not removed. The partially split seeds with cracked seed coats at this stage of the process are known as *dol*. The above two stages of the process can be carried out soon after bringing the produce from the fields if desired, or at any other suitable time.

(3) *Treating the dol with vegetable oil and storing it.*—The *dol* so obtained is not usually made into the final dhal immediately. It is treated with a small quantity of vegetable oil at the rate of about 2 lb. per 100 pounds of *dol*, and stored for varying periods. If the storage period is to extend for more than a month castor oil is used; gingelly oil being used if the storage period is less than a month. Storing of *dol* treated with oil for at least a fortnight is considered necessary. The chief object of treating *dol* with oil and storing it for some time is to allow the slightly cracked seed coat of the pulse to absorb the oil making the seed coat soft and thus assisting considerably in the final splitting of the pulse into dhal and the removal of the seed coat from the split dhal. The treated material should remain oily during the entire period of storage. The variation in the storage period offers an opportunity to distribute the dhal making business over a longer period of the year so that it can be done at convenient times.

(4) *Second sun-drying.*—After the storage period is over, the oil-treated and stored *dol* is again exposed to sunshine for two to five days depending upon the prevailing temperature.

(5) *Final splitting.* This is also done at noon. The material is fed to the same stone mill, preferably in a warm condition at slower rate and in smaller quantities than during the preliminary splitting. During the course of

this operation the seed coats will separate, and a large portion of the unsplit material will also be split up. During splitting the mill must move comparatively slowly as otherwise a great proportion of the dhal is likely to be broken up.

(6) *Sieving and winnowing.*—The split dhal is then separated and cleaned from the seed coat by sieving and winnowing. The small broken pieces are also separated as far as possible.

(7) *Treating finally with vegetable oil.*—The dhal is then finally treated with castor or gingelly oil at the rate of about 2½ lb. per 100 lb. of dhal and is ready for sale. The final oil treatment is intended to preserve the quality of dhal, prevent insect attack and make it of attractive appearance.

This method of dhal-making is rather expensive because of the use of vegetable oil at two stages, and the extra labour required in double splitting. Moreover, the proportion of broken dhal is much higher. From 100 lb. of seed about 66 lb. of clean good quality dhal is obtainable. The rest is broken material and the seed coats.

The outer covers of the seed in admixture with the small broken pieces of dhal obtained as a by-product in dhal-making is known under the name of *chuni* throughout India. It is a favourite concentrated foodstuff for dairy cows.

Wet Method of Making Dhal.

The seed collected by professional dhal makers is allowed to soak in water for about six hours either in tubs or in well constructed vats. The free water is then removed or drained away. At this stage, fine, well sieved earth preferably of the red laterite type is added at the rate of about 5 lb. per 100 lb. grain and well mixed. The mixture of soaked grain and moist earth is heaped up and kept in that condition for the night. Next morning, the heap is broken up and the material exposed to the sun for drying. The drying continues for a day or two according to the temperature. After thorough drying the seeds are again mixed up with a thin turbid mixture of red soil and water and heaped up for the night. Next morning they are removed and thoroughly dried. They are then sieved and winnowed to remove the earth and other impurities. The seeds are finally split into halves in the stone mill.

Cultivators who prepare their own dhal adopt a slightly modified method which is more laborious and takes more time, but the dhal obtained is of somewhat superior quality. Instead of soaking his seed in water the cultivator prepares a thin mixture of red laterite soil and water and applies this earth solution to his seed at repeated intervals of about an hour throughout the day. Each time the earth solution is well mixed up with the seed by repeatedly turning over the heap. By this method the seeds do not absorb moisture in free water but the absorption of moisture is being effected gradually in several stages. The heap remains undisturbed throughout the night. In the morning the seed is exposed to the sun for drying and then finally split up into dhal.

The professional dhal makers allow the seeds to absorb a larger quantity of moisture and the seeds swell considerably. On drying such seed the shrinkage is great and therefore the resulting dhal assumes a marked depression in the centre. In the cultivator's method, as the soaking is gradual and according to requirements, the resulting dhal does not have so prominent a depression in the centre.

By the wet method, 100 lb. of seed yield about 80 lb. of marketable dhal. The breakage of dhal is low. The object of wetting and drying is of course, to produce a contracting and expanding action on the seed coat which, as a result, offers much less resistance when the seeds are being split in the mill.

Concluding Remarks.

A close observation and study of the conditions under which *Cajanus cajan* is cultivated in India indicates that some of the varieties of this plant are capable of successful cultivation for seed production in the dry parts of Ceylon. The small scale processes of dhal-making described above are fairly simple and do not require expensive outfits. The requisite number of dry sunny days are available in the dry zones for the preparation of dhal. The local consumption of dhal in Ceylon is considerable. Under the circumstances, it is quite possible with some effort and attention to produce good quality dhal for local consumption. The crop itself is likely to prove an important rotational crop or an appropriate mixed crop in the village agriculture of this country, while the preparation of dhal offers an opportunity of being taken up as a new and profitable cottage industry in the dry zone.

REPORT.

THE FIFTEENTH MEETING OF THE ADVISORY BOARD OF AGRICULTURE.

PRESENT.

The Director of Agriculture	....	*Chairman*
The Deputy Director of Agriculture (ag.)	....	
Hon. F. J. Seaford, O.B.E.		
„ Peer Bacchus		
„ J. W. Jackson	....	*Members*
„ R. E. Brassington		
Mr. W. H. Richards		
Mr. S. Andries		

with

Capt. J. F. Irving, M.C.	....	*Secretary*

ABSENT.

Mr. R. B. Hunter.	....	*Member*

An excuse for non-attendance was tendered for Mr. R. B. Hunter.

The minutes of the last meeting held on March 21, 1938, which had previously been circulated, were confirmed.

The Chairman referred to the following matters arising out of the minutes:

(1) *Cattle Branding Ordinance.* No further communication had been received from Government but the intention so far as he knew was not to proceed with the amendments. Hon. F. J. Seaford said that enquiries had recently been made by the Rupununi ranchers as to the placing of brands on animals in such a way as not to prejudice the value of the hides and Government had been written regarding the proposed amendments. He asked that if the matter were again referred to the Board it should receive early attention. Hon. Peer Bacchus remarked that from his experience a large brand was useful in the country districts as it enabled owners to recognise their animals from a distance. Members thought that changes as regards size and position of brands might apply to Rupununi cattle only at first.

(2) *Berbice Exhibition.* It was proposed to make arrangements for holding the postponed show next year.

(3) *Glasgow Exhibition.* The Department had forwarded agricultural products in co-operation with the Departments of Forestry and Lands & Mines.

(4) *La Belle Alliance.* The Director of Public Works was proceeding with the drainage of the area and a start was being made with the sand reef for buildings and stables, etc.

(5) *Government Veterinary Surgeon.* Consequent on the retirement of Major T. Bone, Mr. H. A. Fraser had been appointed to act in his place.

(6) *Reduction on Railway Freights.* The Deputy Director had gone into the matter with the Managing Director, Transport Board, who had supplied a tariff with all the information on the subject.

Unfortunately, the Managing Director had stated that he could hold out little hope of any decrease; rather there was every chance in view of the increased cost of wages, etc., of the possibility of freight charges having to be increased. It was unanimously agreed that Hon. Peer Bacchus and the Secretary should see the Managing Director on the subject.

Coffee Committee's Report. The Chairman said that the report of the Coffee Committee had been submitted to Government, but as this was not yet published he was not in a position to discuss the matter at present.

Flue-curing of Tobacco. The Chairman reported on the results that had been obtained in connection with the tobacco flue-curing experiment. About ¾ of an acre had been planted at Sophia and a small flue-barn had been built. The results obtained had been fairly satisfactory and the two local tobacco factories had stated that they were prepared to buy a limited quantity of local tobacco but would not commit themselves beyond a certain figure, as this would depend entirely on the quality of the article produced. It was essential, however, that whatever is grown must be properly cured, packed, etc., and as there are many defects still to be overcome—although the local factories have stated that the leaf so far supplied is the very best they have seen locally—the Secretary of State had been approached for assistance from the Colonial Development Fund Advisory Committee to obtain the services of an expert in flue-curing methods and barn construction. This officer would be of great assistance in the proper construction of barns and would be available for instructions in the principles, practices and technical aspects of curing tobacco. The Board were unanimously of the opinion that the project, which appeared an encouraging one for the creation of a minor industry, should be helped in every way possible although the question of offsetting the revenue loss through customs duties which was raised by Hon. F. J. Seaford, would, no doubt, have to be considered at a later date.

Fruit & Vegetable Conference. The Chairman stated in connection with the Fruit and Vegetable Council Meeting at Trinidad, he had introduced a motion recommending that the intercolonial fruit and vegetable trade be carefully investigated by the Governments concerned, both from the commercial as well as the quarantine aspects, with a view to its proper organisation and control. A copy of the resolution and the related correspondence had been

forwarded by Government to the Georgetown Chamber of Commerce and this body had decided to raise the question at the next meeting of the Associated Chambers of Commerce to be held shortly in Trinidad.

Bananas. The Chairman said that he regretted to have to report adversely on the progress of the banana plots both at Middlesex and Supply. The losses sustained from Panama Disease at Middlesex to date were approximately 30% of the stools, while Leaf Spot disease was still very active in spite of spraying. Of the bunches reaped to date only a small percentage were of the "count bunch" class *i.e.*, 9 hands ; 7-hand bunches were fairly common. Mr. Richards asked what was the amount placed on the estimate for the work and was informed that $750 had been allocated this year. He said he considered that matters had gone far enough and the plots should be immediately closed down, as it was a pure waste of money to go on further with the experiments. The Chairman said he hardly liked to suggest this step as false statements were being made that the Department of Agriculture did not want to see a banana industry, although the whole subject had been fully ventilated in the Legislative Council. It was agreed that a memo. should be published on the results so far obtained and that Government should be informed that in the opinion of the Board further expenditure did not seem justified.

Shipment of Limes. The Chairman reported that recently a shipment of 20 crates (about 3,200 fruits) of green limes had been made to Canada for which the sum of $24.58 had been received. The expenses including freight, cost of crates, etc., had amounted to $19.24. The small balance would leave little actual profit to the North-West grower on whose behalf this effort was made.

Anthrax. The Chairman reported that he regretted to announce that Anthrax had broken out in the County of Berbice, at Plns. Bohemia, Susannah and Hermitage, as well as at Plns. Palmyra and Seawell. Every effort was being made by the Department in collaboration with the Police authorities to control the spread. The Medical Department also was involved and had taken steps to prohibit the sale of milk from the infected areas. He feared that the Veterinary Preventive Measures Vote would be inadequate as special constables had to be employed to control cattle movements, but this could not be helped under the circumstances.

Livestock. In connection with other Livestock matters, the Chairman mentioned that arrangements had been made for a bull pen to be erected shortly at Whim, Corentyne, and he also hoped to place some pure bred poultry and a purebred boar there. He further stated that as export of poultry and eggs had been taking place from Berbice to Trinidad by the small Dutch steamers calling at Springlands and New Amsterdam, the time seemed opportune for creating additional interest in poultry rearing. He was glad to announce that it was the wish of a number of interested persons to resuscitate the Poultry Association and a meeting was being held in this connection on August 12, at 4.30 p.m. to which he welcomed members of the Board. This was considered a step in the right direction.

Arrival of Rice Mill Engineer. The Chairman referred to the future visit of Mr. Parker, rice mill expert, whose experience in connection with Rice Mills elsewhere should prove of great benefit to the rice industry in this Colony.

District Agricultural Committees. The Chairman sought the advice of the Board as to whether the need any longer existed for District Agricultural Committees, of which there were two, in view of the fact that there was now a properly constituted Advisory Board of Agriculture, as it meant considerable duplication of work. Several members who served on such District Agricultural Committees agreed that they no longer served any useful purpose. The feeling was that they should be discontinued, but the question of publishing the minutes of the Board might be re-opened.

Information for Colonial Empire Marketing Board. The Chairman informed the Board that notes had been prepared and submitted to Government for the Colonial Empire Marketing Board on the various products of the Colony for which remunerative markets were urgently required, *e.g.*, coffee, plantains and by-products, cassava and by-products. The position in regard to rice had also been dealt with and the need for help in the utilization and disposal of fruit products, juices, etc., had also been emphasised.

Economic Survey of Cane Farming. Certain figures in an article published in the *Agricultural Journal*, by Mr. H. D. Huggins in connection with cane farmers' yields were questioned by the Hon. R. E. Brassington who considered that the results shown were too high. The Hon. F. J. Seaford said it was possible that the figures were a misprint. Mr. Huggins who was present by invitation said he considered the figures were substantially correct from information obtained by the survey method direct from the farmers, but he would go over them with a view to making any corrections if necessary.

Malva fibre. Attention was called to a note which appeared in the "*Daily Argosy*" about Malva fibre in which it was stated that the Department of Agriculture had put a stop to a possible successful enterprise in 1929.

The Chairman stated that the early records of the Department showed that interest had been taken in Malva fibre for some time prior to 1929 and that this particular plant—*Malachra capitata*—had been tried out commercially in many countries, notably India, but it had been given up as hopeless. The following note by Sir John Harrison in 1925 setting out the position was then read:—

"The reasons why Malachra fibre has not been developed commercially are simple; (a) low yield of fibre from the stems; (b) the great difficulty of separating the commercial fibre from the stems by retting and beating. The beating has to be done by hand, no machine having been invented for this purpose.

"I have recently had samples of Malachra fibre prepared at the Botanic Gardens from plants growing at Sophia Station. The yield of clean fibre was rather

less than 3 per cent. of the weight of green stalks. The cost of gathering the stalks, retting them and separating the fibre by hand labour was somewhat over $708 per ton of the fibre obtained.

"Personally, I fail to perceive that we are missing anything beneficial to the Colony by not undertaking the commercial exploitation of a fibre product the production costs of which are $708 per ton in British Guiana and which issaleable in London at £60."

Since that minute was written by Sir John, further trials had been made by the Department but results were not such as to justify immediate commercial exploitation. The plant occurs wild in the Colony, but under cultivation, even when thickly seeded, does not establish itself in an even stand, while the stalks produced are of varying lengths and inclined to branch. The files show that a certain individual in 1929-30 approached Government with proposals covering the cultivation of 100 acres, using as a basis of his yield figures the returns from 65 selected plants. It was explained to him that it would be very unwise to base conclusions on such a small number of plants and that before embarking on an extensive layout, he should arrange to cultivate say five acres under the aegis of the Department of Agriculture. Government approved of this and the individual was so informed. The Agricultural Officer in the North West District was instructed to co-operate and give every possible assistance and advice to the venture but the person concerned allowed the matter to slide and took no action.

The Board agreed that this explanation should be recorded in the minutes.

The meeting then terminated.

NOTE.

Padi and Rice Production in India and Burma.—In order to appreciate and to make a comparison of the acreages, etc., under padi cultivation in India and Burma with this Colony, the following is a short précis of a report taken from "Agriculture and Animal Husbandry in India, 1935-36".

Padi occupies about 35 per cent. of total cultivated area in India and in 1935-36 the estimated area was 81,841,000 acres producing 27,902,000 tons of rice. Rice accounted for ninety-one per cent. of the total quantity of food-grains and flour exported during 1935-36. In 1935-36 the production in India proper was 22,843,000 tons and in Burma 5,018,000 and the exports were 191,000 tons for India proper and 1,213,000 tons for Burma. The exportable surplus is derived almost entirely from Burma. Burma was responsible for eighty-six per cent. of the total tonnage of rice shipped overseas in 1935-36. In British Guiana (1936 census) 62,856 acres were reaped, producing 36,348 tons of rice, whilst the total rice exports for the same period were 20,559 tons.

One of the main activities of the provincial departments of agriculture in India and Burma with regard to rice is the distribution of improved strains to the cultivators, the total area under improved varieties being 3,667,097 acres in 1935-36. Rice research is now being conducted on a wider scale than ever, chiefly as the result of finances provided by the Imperial Council of Agricultural Research. A Standing Committee on Rice consisting of forty-five members was constituted during the year on the lines recommended by the Crop Planning Conference, 1934.

BENGAL contributed 25.8 per cent. in area and 28.8 per cent. in production of the total Indian crop. The reported area for the year, 21,092,000 acres, was nearly the same as in the previous year, but the production, 7,208,000 tons, had gone down by nearly twelve per cent. Plant-breeding work on rice is carried on at various stations and special attention is paid to the propagation of varieties and strains recommended by the Department. The number of seed-farms increased from 334 to 369, during the year, the area increasing from 3,000 acres to 3,025 acres. At the headquarters of the Economic Botanist, 2,075 types of highland *aus* (autumn paddy), transplanted *aman* (winter paddy) and other rices were under observation. The most promising of these are usually picked out by preliminary observations for detailed yield tests. During the year thirty-four selected varieties were under yield trials. A number of hybrid progenies were compared against the parents for hybrid vigour. A large number of generations of crosses were under study. Histological studies on the distribution of mechanical tissue in the straw, were continued on materials from rices with lodging and erect habits and of their crosses. Results reported previously—

that copper sulphate treatment preserves the viability of seed during storage—are found to hold good only when the treated seed is stored in air-tight receptacles. Analyses of paddy and rice samples and cooking tests were carried out in connection with the co-ordinated scheme of marketing survey in rice initiated by the Imperial Council of Agricultural Research. Due to bad season and persistent drought several of the yield tests had to be abandoned. At the Bankura station several cultural and manurial trials were continued. In a complex experiment dealing with broadcasting, dibbling and transplanting with two ages of seedling, both dibbled and broadcast sowing gave a significantly higher yield than transplanting and between the two sowings, dibbling was better than broadcasting. The pot experiment with regard to the best time of applying Nicifos showed that its application at a much later period than transplanting time is beneficial. Increased doses of Nicifos, were, as in the previous year, more effective on yield tillering than smaller doses.

The province of BIHAR and ORISSA contributed 16.5 per cent. in area and 14.8 per cent. in production of the total crop in India. Scientific work is carried on in the central station. The substations deal with simple selection in local varieties and in addition arrange for the trial of strains evolved at the central station. Nearly 5,000 samples have been collected from different parts of the province and are being grown and examined with a view to eliminating duplicates and recording morphological characters. Selection work on types suitable for flooded conditions was also duplicated by subjecting the selections to flood conditions artificially and eliminating the unsuitable types. The selection work in certain rices has resulted in a few improved strains which show promise of being better both in quality and yield than some of the present standard varieties. Over fifty rice varieties imported from outside the province were under observation for determining their suitability to the Bihar conditions. A study of the root-systems of rice under different conditions of soil has shown the comparatively better developed root-system in *aman* as compared with *aus* rices, and that the root-system is best developed in clayey soils, the mixture of sand in it inhibiting such development. The investigation on the factors governing "Quality of fineness" in rice has shown that the weight of grain per unit length, *i.e.*, $\frac{\text{weight of 100 grains}}{\text{length of the sample}}$ is a much more reliable index than ordinary $\frac{\text{length}}{\text{breadth}}$ ratios. Several cultural experiments were continued. Trials on spacing and number of seedlings per hole in transplanted rice showed that it is more economical to transplant 9″ apart with only two or three seedlings to the hole. Dibbling of seed was also found to be superior to broadcasting. The practice of dewatering the field for about a fortnight at a certain stage of the crop again failed to show any advantage over the normal irrigation practice. In the manurial trials, Ammophos and ammonium sulphate were both equally good as fertilisers and definitely better than sodium nitrate for South Bihar conditions, and superphosphate was not of any value. Manuring of seed-bed did not show any beneficial effect on the subsequent growth and yield of the crop, and it appears that the best time of applying artificial manures to rice is about two weeks after transplanting.

On the physiological side, studies of the mineral and water requirements of the rice plant have been in progress. Ammonium salts appeared to be much more beneficial than nitrate salts. *Re* water-requirements of the crop, there appeared to be a good deal of variation within each group of early, medium and late varieties. There is also a well-marked period of high water-requirement which starts about two to three weeks before flowering and continues right up to the flowering time after which it begins to decline gradually. Studies on salt-tolerance indicated the possibility of gradually educating varieties to tolerate salinity. Desiccating agents like calcium chloride or sulphuric acid were found to help the seed in retaining its viability for long periods, up to twenty-six months. A study of the F_2 generation of some crosses indicated great complexity in the inheritance of characters, both morphological and agricultural, and the work is being continued.

BURMA claims on an average of the last three years 15.5 per cent. of the total area and 17.5 per cent. of the total production of India. The area and production during the year were 12,494,000 acres and 5,018,000 tons respectively. Unlike other major provinces, the production during the year was slightly above normal and about ten per cent. more than in the previous year. Although Burma is responsible for eighty-six per cent. of the total export of rice from India, the quantity exported during the year declined to 2,965,000 tons from 3,599,000 tons in 1934-35. Since the rice industry in the province is dependent on her retaining her foreign market, attempts have been mainly devoted to the production of rices to compete with the high-grade American and Spanish rices in the United Kingdom and Canada. In addition to two improved Emata rices, two Ngasein types have emerged successfully from tests conducted at eleven centres. These rices have been approved as suitable for both Western and Eastern markets and seed is now being grown for commercial milling and trial shipment. 15,468,717 lbs. of improved seed was distributed during the year. The breeding work at the Central Station consisted of the study of 180 hybrid cultures of crosses between local strains and local strains, and between local strains and exotic varieties to evolve high-yielding types with big, bold and translucent grain suitable for the export market. A large number of exotic varieties was also studied but most of these did not prove suitable for Burma conditions except two from Siam. Under genetical studies, the inheritance of sterility proved complicated and no connection was established between sterility and pollen abortion. The inheritance of grain-size was of the usual multiple-factor type, and grain shattering was found to be dominant over non-shattering. Under manurial trials the experiment with a mixture of ammonium sulphate and sodium nitrate has definitely proved that ammoniacal nitrogen is to be preferred for rice.

Investigations on the photoperiodism in rice conducted at Mandalay by the Economic Botanist have shown that the influence of the length of day profoundly affects the time of flowering. By artificially shortening the day a rice variety

can be induced to flower in forty days from sowing which would normally require 135 days from sowing. There was, however, much sterility when flowering occurred during the hot day season (April).

MADRAS.—This province contributed about 13.5 per cent. of the area and to about 18.1 per cent. of the production of the total Indian crop. The reported area for the year was 10,478,000 acres and the production 4,880,000 tons. Nearly forty improved strains have been evolved suited to the varied conditions of rice-growing obtaining in the province and the area under them is rapidly increasing. Progress in the spread of strains was marked. Amount of seed sold to cultivators was 2,479 tons. Seed-farms under departmental supervision and through agricultural co-operative societies were arranged. Total area under different improved strains of rice including natural spread was estimated to be 1,063,299 acres. Most of the fundamental work on rice is carried on at Coimbatore but the district sub-stations deal mainly with simple selection work in local varieties and also conduct agronomic experiments suited to the local conditions. Six strains from two stations are being released for general distribution to cultivators. Two strains from Coimbatore are of hybrid origin combining valuable economic characters. Under cultural experiments work at Coimbatore has shown that dibbling the seed in lines in puddle is just as good as transplanting. Manurial trials gave tho following results: Phosphatic manures, in whatever form, had no response. At one station green manures were better than mineral fertilizers applied to give the same amount of nitrogen. At another station applications of nitrogenous fertilisers over a dressing of green leaves gave definite increases in yield and the increase is progressive with higher doses of leaf application from two to ten thousand lbs. per acre and there is a definite residual effect with the heavier doses. Irrigation experiments at Coimbatore and Maruteru showed that in the former place a rice crop (August to January) consumes seventy-eight acre-inches with a duty of about fifty and that in the latter, the crop (June tc November) consumes fifty-four inches with a duty of about seventy. Under fundamental studies carried on in Coimbatore, the inheritance and linkage relationship of some of the morphological characters have been worked out. The cytogenetic study of a large number of mutations isolated from the X-rayed material and polyploids was in progress and is expected to be of considerable help in determining linkage groups and the basic number of chromosomes in rice. Histological studies showed that the coarse and coloured rices have thicker bran layers than the fine and white rices. In connection with the marketing survey, a simple laboratory method for cooking test was designed. Two hundred and seventy-five samples of paddy and rice were analysed and cooking values determined for forty samples of rice.

THE UNITED PROVINCES contribute 7.8 per cent. in area and 6.7 per cent. in production of the total crop in India. The area and the production were 6,643,000 acres and 1,983,000 tons respectively. The total quanity of seed distributed during the year was 993,594 lbs. The research work is carried on

at Nagina. There were fifty-three varieties comprising indigenous and exotic ones grown as single plant cultures. Over a thousand cultures from hybrids were under study. The several manurial and cultural trials were repeated during the year. The one important observation made in the several manurial trials was that there was no difference among the treatments and none of them did better than the control. Interploughing of the broadcast crop one month after sowing failed to give any effect. An experiment with different quantities of water, forty, sixty and eighty acre-inches showed no differences among them, indicating that forty inches was quite enough. Studies on germination and viability of rice seed showed that in early and medium ripening types the panicles might be harvested twenty days after their emergence without affecting the viability of the seed adversely. Hulling trials showed a correlation between fineness of grain and breaking percentage. The fine-grained types gave a higher percentage of broken grains than bold fine, medium fine and short and round types. *Re* breakage during milling, crude parboiling of paddy was superior to "dry" hulling. Though storage improved the hulling properties, the hulling quality did not differ between transplanted and broadcast rice.

THE CENTRAL PROVINCES AND BERAR contribute 6.9 per cent. in area and 5.8 per cent. of India's total production on an average of three years. The area and production were 5,665,000 acres and 1,484,000 tons respectively. The total quantity of rice distributed as seed during 1936 was 12,966,250 lbs. Research work is carried on at Raipur and special emphasis is being laid on biochemical problems. Results of chemical analysis have shown that a high percentage of total phosphoric acid in the soil does not necessarily lead to a high yield in rice and that there appears to be an inverse relationship between the lime-content of the soils of a particular tract and the yields of rice obtained. Determinations of soil-acidity have shown that in the case of most of the soils examined, the acidity increases with depth and high yields of fine varieties of rice can be obtained only from neutral or slightly acidic soils. Most of the soils examined showed a lack of humus, its percentage being highest within the top six inches. The humus content did not show any relationship to the carbon-nitrogen ratio, which varied widely with different soil groups and was lower at a depth of six to twelve inches than in the top six inches of the soil. The existing varieties of rice grouped according to their times of ripening and quality were tested for yield and 168 out of 803 have been retained for further trial. The hybridisation work in progress has got a double object in view, namely, securing heavy-yielding types, and types with deeply pigmented morphological parts as leaf-sheath, auricle, etc., to distinguish them easily from wild rice. Experiments with nitrogenous and phosphatic manures either singly or in combination showed that there was no response for nitrogen even up to forty pounds per acre and the response to phosphoric acid did not vary for applications of twenty to forty pounds per acre. Comparison of Nicifos with ammonium sulphate showed that the former had a residual effect while the latter had not. Varying doses of Nicifos from fifty to three hundred pounds per acre all gave significantly higher yields than the

no-manure plot and the higher doses left a greater residual effect than the smaller doses. The cultural experiment with broadcasted and subsequently cross-ploughed, drilling, etc., showed that on sandy loam land, in all varieties tried, transplanting was better than broadcast-sowing and drilling.

ASSAM contributed to the total rice area and rice production in India 6.1 and 5.4 per cent. respectively on a three years' average. The acreage and production were 5,292,000 acres and 1,610,000 tons respectively. The research work is carried on at Karimganj and Titabar. A certain number of strains, selections and cross progenies suited to conditions have already been evolved and distributed, such work forming one of the important activities of the department. Work with varietal, cultural and manurial trials besides breeding and selection were carried out. Under the scheme of analysing market samples of paddies and rices to fix grade standards, 134 samples were examined. Cooking tests were also conducted with twenty-two samples of rice. Problems relating to deep water rices are peculiar and entail special equipment to study them properly. Cultural experiments with time of sowing and seed-rate and complex experiments involving time of planting, spacing, age and number of seedlings per hole in certain rices have been laid down and preliminary results obtained.

BOMBAY contributes on an average of the last three years 2.4 per cent. in area (1,832,000 acres in 1935-36) and 3.1 per cent. in production (740,000 tons in 1935-36) to the total rice crop in India. Bombay imports considerable quantities of rice from Burma and other provinces and re-exports portions of it to Africa, Persian Gulf, etc. During 1936, 30,000 lb. of seed was distributed to registered seed-growers. The area under the improved strains is estimated to be 13,524 acres. Breeding work is carried on.

SIND contributed about 1.5 per cent. of India's production out of a little over a million acres. 497,822 lb. of seed was made available to cultivators. Breeding work is carried on which has resulted in three improved strains. The improved hybrid strain obtained by crossing Kangni 27 with Kolamba 184 and which has been named 'Silver Jubilee' rice was tried at several places on a large scale and has given satisfactory results, the yield per acre going up to 3,400 lb. A large number of exotic varieties has been tried but most of them are not promising. Experiments with duty of water showed that a normal crop with fairly good yields can be raised in a normal season with thirty duty, the crop consuming about forty-five to fifty-five acre-inches.

Rice is a minor crop in the PUNJAB and occupies less than a million acres. Breeding work is carried on and a total supply of 355,962 lbs. of seed of improved varieties was distributed. A large number of local varieties (sixty-four) has been tested at the station and variety 246 Suffaida continues to be outstanding. Under cultural trials transplanting is found to be better than broadcasting and seedlings of ages above six weeks were better than younger seedlings below five weeks.

The HYDERABAD STATE contains over a million acres under rice in 1935-36, but produces only about 336,000 tons of rice. Selection work has given two early types. Other more promising types are under test. The area under improved strains during the year is 1,765 acres.

The area under rice in MYSORE during the year was 741,000 acres and the estimated production 222,000 tons. Breeding work is carried on. Some of the new Mysore selections are very promising and district trials have created a demand for them by the cultivators. During the year 65,000 lb. of padi seed was made available to cultivators and the area under improved strains in the State is estimated to be 53,000 acres.

The area under rice in the TRAVANCORE STATE is small and nearly fifty per cent. of the requirements has to be met by imports. Side by side attempts are in progress by the Agricultural Department to improve the yields in existing areas by the spread of improved strains and by advocating better manuring practices. During the year 6,889 lb. of seed was sold. Certain manurial trials in progress have shown that addition of bone-meal, fish guano or laurel cake definitely increases the acre-yields.

COCHIN.—Rice is an important crop and though no regular breeding work is done, simple selection has been attempted and one of the strains evolved is becoming popular. Manurial trials in rice have shown the importance of organic manures.

Breeding work on a small scale is being carried out at KARNAL station. A preliminary experiment with four types of rice showed that transplanting seedlings with regular spacings was better than the local practice in which no regular space is maintained.

F.B.

NEWS.

The Director of Agriculture visited Berbice from September 14 to 17.

The Deputy Director of Agriculture visited Berbice from August 22 to 26 and Essequibo from August 29 to September 3.

The Government Veterinary Surgeon visited Berbice on several occasions in an effort to control an outbreak of anthrax in that area.

Members of the Essequibo Central Rice Mill Committee including the Director of Agriculture and Mr. H. D. Huggins visited Essequibo on July 8 in order to make an inspection of the mills and to interview those connected with the Essequibo rice industry.

Mr. James D. Gillespie, B.Sc., Agricultural Superintendent in this Department, left the Colony on August 30, on six weeks' vacation leave from date of arrival in the United Kingdom, prior to taking up his new post as Agricultural Officer, Sierra Leone. He takes the best wishes of his colleagues with him in his new sphere of activity.

With effect from September 12, 1938, inclusive, Miss N. Green, Class III Clerk of this Department, has been seconded to the General Register Office and Miss S. Lord, Probationer of that office, has now joined the staff of the Department of Agriculture.

Mr. H. Balkaran Singh, of the Sugar Experiment Station Laboratory, has passed the Final Examination in Sugar Technology of The City and Guilds of London Institute. Mr. Singh is to be congratulated on his success.

Mr. Hubert Parker, Manager of Government Rice Mills, Federated Malay States, who has been detailed to investigate the possibility of the erection of a Central Rice Mill in Essequibo, and generally to go into rice milling problems in the Colony, arrived in British Guiana on September 19. Before leaving for the districts, Mr. Parker is spending the first few days of his visit in Georgetown studying matters connected with the industry.

Among the visitors to the Department was Mr. Herbert G. Ford, Sales Representative of the U.S. Phosphoric Products Corporation, Broadway, New York.

A meeting of the Advisory Board of Agriculture was held on Wednesday, August 10.

Efforts are being made to reawaken local interest in poultry and the Poultry Association has been resuscitated. Meetings were held at the Head Office, Department of Agriculture, on August 12 and 19 and September 5. Rules were drafted and adopted and a President and other officers elected.

At a Village Chairmen's Conference held on Tuesday, August 16, at La Grange, West Bank, Demerara, His Excellency the Governor attended and gave an address. The Director of Agriculture was also present and made a short reference to the possibilities of a poultry industry in village areas.

PLANT AND SEED IMPORTATION.

Introductions by the Department of Agriculture for the period June—September, 1938.

Name	Quantity.	Whence Supplied
Economic.		
Mango, 7 varieties	4 seeds each	Puerto Rico Agrl. Experiment Station.
Cauliflower (Maincrop Benares)	2 oz.	Sutton & Sons (Calcutta).
Dioscorea alata	tubers	Agrl. Dept., Dominica,
Padi, 6 varieties	½ oz. each	Orissa, India.
Padi, 5 varieties	½ oz. each	São Paulo, Brazil.
Guava, 3 varieties	1 oz.	Kirkee, India.
Peas, 14 varieties	½ oz. each	Pusa, India.
S rgo, 2 varieties	½ lb. each	U.S. Dept. of Agric., Washington, D.C.
Bananas, (Hawaiian Cooking) 4 varieties	suckers	Canal Zone Expt, Gardens.
Ornamental.		
Early Flowering Sweet Pea	2 pkts.	Sutton & Sons (Calcutta).
Nelumbium luteum	3 oz.	Dept. of Agriculture, Jamaica.
Frangipanni, 3 varieties	cuttings	Dept of Agriculture, Barbados.
Alstonia sp.	1 pkt.	Dept. of Agriculture, Bermuda,
Peristrophe speciosa	do.	Dept. of Agriculture, Bermuda.

METEOROLOGICAL DATA—APRIL TO JUNE, 1938.

Recording Stations & Months.	Rain-fall. Total Inches.	Number of Days of Rain: Under .10 Inch	.10 to .50 Inch	.50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days.	Evaporation Inches	Air Temperature and Humidity. Maximum.	Minimum.	Mean.	Humidity Mean.
Botanic Gardens.												
April ...	7.95	4	5	7	2	...	18	4.17	84.4	76.3	80.3	82.0
May ...	11.17	5	15	6	2	...	28	4.12	84.9	76.2	80.5	84.8
June ...	13.17	4	12	6	4	...	26	3.92	84.5	75.3	79.9	84.3
Totals	32.29	13	32	19	8	...	72	12.21	...	...	...	...
Means	...	...	...	...	...	...	...	...	84.6	75.9	80.2	83.7
Berbice Gardens.												
April ...	15.75	5	7	4	4	2	22	...	86.4	75.1	80.7	82.9
May ...	15.01	9	7	5	4	1	26	...	87.7	75.5	81.6	82.9
June ..	8.84	6	9	3	3	...	21	...	87.2	75.1	81.1	80.9
Totals	39.60	20	23	12	11	3	69	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	87.1	75.2	81.1	82.2
Onderneeming.												
April ...	11.21	1	11	3	4	...	19	...	84.9	74.5	79.7	90.9
May ...	14.80	3	12	9	2	1	27	...	85.1	74.1	79.6	92.4
June ..	12.58	2	11	9	2	...	24	...	84.6	72.7	78.6	93.1
Totals	38.59	6	34	21	8	1	70	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	84.9	73.8	79.3	92.1
Hosororo, North West District												
April ...	10.91	7	7	4	3	1	22	...	84.8	70.5	77.6	86.1
May ...	12.31	4	11	9	1	1	26	...	85.5	71.6	78.5	88.6
June ..	13.80	3	15	7	3	...	28	...	85.7	71.1	78.4	87.5
Totals	37.02	14	33	20	7	2	76	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	85.3	71.1	78.2	87.4

CURRENT PRICES OF COLONIAL PRODUCE

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XXI, No. 8, Wednesday 31st August, 1938.

SUGAR.

Per 100 lb. net   3 lb. per Bag allowed for tare

Dark Crystals for Local Consumption........................$3.30
Yellow Crystals do. do. $4.00
White Crystals........................$4.75
Molasses Sugar... ....none offering.

Above Prices include Excise Tax of 90c.

RUM.

Imperial Gallon.   Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export)...60c.; Hhds. 52c., Barrels 77c.
White, in Hogsheads—40 to 45 O.P...(for local consumption)...............45 to 55c.

MOLASSES.

Per Imperial Gallon.   Naked.

Yellow (firsts)........................10c.
Yellow (seconds)........................5½c.

RICE.

Rice..........per Bag of 180 lb. gross. Brown Super $5.00 scarcity; Extra No. 1, $4.25—$4.50; White, None available. Lower Grades $3.35—$3.65 as to quality
Padi..............per Bag of 143 lb. gross, $1.20—$1.50 as to quality.

GENERAL.

Gold, Raw,........................average per oz. $26 to $27.
Diamonds,—pro rata as to quality........................average per carat $10 to $11.
Timber, Greenheart, (Lower grade measurements)...40c. to 60c. per c. ft.; for export 72c. to $1.00 per c. ft.
do. Railroad Sleepers—(Mora) ....$1.68 each.
Greenheart Lumber........................$70 to $80 per 1,000 feet.
Crabwood Lumber........................$60 to $75 per 1,000 feet.
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,........................$4.50 to $6.00 per M.
Charcoal, Capped for shipment........................72c. to 85c. per bag.
Firewood........................$2.50 per ton.
Coconuts...Selects, $9.00, culls $6.00 per M...Copra $2.50 per 100 lbs. prime Copra.
Balata........................Venezuelan, none. Local Sheet...36c. to 38c. per lb.
Cocoa........................19c. to 19½c. ,, ,,
Coffee........................6c. to 6½c. ,, ,,

N.B.—Duty Payable on value at time of Importation and rate of exchange on day of arrival.

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The

Agricultural Journal of British Guiana.

December, 1938.

EDITORIAL.

ROYAL COMMISSIONS—PAST AND PRESENT.

When the Royal Commission arrive here early next year it will be just over 42 years since the last Royal Commission was in the Colony, and comparison of the state of affairs then and now gives food for thought. Since the last Commission the wheel has turned a full cycle, for from the state of depression which brought about the arrival of the first Commission, the Sugar Industry, ever the mainspring of the colonies, has risen to prosperity during the boom years of the war, and dropped back again to necessitate the Sugar Commission of 1929. Despite the advances made by the industry both in field and factory, the last nine years have been difficult ones and, economically, the planters today are again faced with a position similar to that obtaining in 1896, but it is to be hoped that the wheel has passed dead centre and that its further movement will be toward better times.

The Commission appointed in 1896 consisted of General Sir Henry Norman as chairman together with Sir Edward Grey, Sir David Barbour and Mr. (afterwards Sir) Daniel Morris as Agricultural Adviser. Its Secretary, Mr. Olivier, was destined to re-cover the ground when, as Lord Olivier, he and Mr. Semple constituted the Sugar Commission of 1929. The '96 Commission came into being as the result of intense depression brought about in the sugar industry by the competition from Beet sugar produced in Europe under a system of bounties. An appeal for assistance from the Home Government had been made by the planters and all those whose fortunes were bound-up with the industry. British Guiana was one of the colonies most seriously endangered by the existing state of affairs, and it was to this Colony that the Commission came first on leaving England, passing on to the West Indian islands and ending in Jamaica, where the effects of the depression were less serious than elsewhere, owing to the increasing number of peasant proprietors, and the possibility of substituting other crops for sugar, notably coffee, and also bananas, which were already coming into prominence.

The present Commission has begun its enquiries from a different point in more ways than one. In the first place, its primary object is to investigate the conditions of labour in the colonies visited, in other words, this time the difficulties of the employee rather than the employer formed the basis of its appointment which was made,

not after an appeal from the colonies, but as the result of discussions in Parliament after the labour unrest in Jamaica had followed closely upon the serious disorders in Trinidad last summer. The Commission this time has visited Jamaica first and will end with the southern colonies, its scope also including British Honduras, which was not visited before.

We may now consider more closely the two Commissions in their relation to British Guiana. When the Norman Commission came to the Colony they were largely concerned with the possibilities, if any, of finding a substitute for sugar, which then, as now, formed 70 per cent. of the Colony's total exports. At that time, gold had recently come into prominence in British Guiana, and it was hoped that it would render considerable help towards swelling the Colony's depleted revenue. Mr. Morris had painted for the members of the Commission a most glowing account of the agricultural possibilities of the interior, which they would not allow to be damped to too great an extent by the somewhat conflicting evidence of the Director of Science and Agriculture, Sir John Harrison.

Crops, the cultivation of which it was suggested at the beginning of the century could well be extended, included coffee, fruit and rice. The viscissitudes which these have undergone in the ensuing years need not be recapitulated—suffice it to state that the only crop which has been able eventually to establish itself in a position of importance, though still very far behind sugar, is rice, which now constitutes approximately 8 per cent. of the Colony's total exports. The answer however, to the query whether the Colony is dependent on a single export crop to a dangerous extent must still be in the affirmative. The position however, is slightly better than it was in 1896 when, if gold were excluded, sugar formed 94½ per cent. of the total exports, and if marketing problems can be solved and milling put upon a sounder basis, rice may be able to exert an ever growing influence on the Colony's budget.

But the present Commission is largely concerned with labour and conditions affecting the labourer; it includes Sir Walter Citrine and two women members with considerable experience of social and health questions. All classes will be given a chance to disclose their grievances, and by the time the Commission reach Georgetown the information and experience that they have gained in the early part of their journeyings will enable them to see these in perspective and judge them on their merits. There have been no labour disturbances in this Colony comparable to the rioting and disorder which occured in Trinidad and Jamaica, but there have been a number of strikes throughout the past eight months and a continual undercurrent of unrest, which has hampered the routine of the sugar estates and disturbed the current of the lives of the great majority of labourers and peasantry, whether discontented or not.

We welcome the arrival of the Commission and hope that when the basic problems have been discussed with its personnel, and we have been enabled to benefit by their deliberations, the Colony with its strangely heterogeneous population will unite to further the turn of the wheel towards prosperity.

MALARIA IN BRITISH GUIANA.

PART III. BREEDING HABITS OF *A. darlingi.* NATURAL FACTORS WHICH LIMIT THE DISTRIBUTION OF THIS SPECIES AND OF MALARIA.

BY

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We have established in the previous sections that *A. darlingi* is the sole malarial vector of practical importance out of the three local common Anopheles; we will now proceed to study the breeding habits of this species as such knowledge is essential for the carrying out of an intelligent control policy.

BREEDING HABITS OF *A. darlingi* IN THE INTERIOR:

We have seen that *A darlingi* is the main malarial vector throughout equatorial South America ; it is eminently an inhabitant of the vast inland forest districts of this region.

Our observations, in this Colony, have been carried out on the mid and upper Demerara, mid-Essequebo and Potaro Rivers. These districts offer good examples of the various conditions which exist in the interior, as regards surface water régime.

The Demerara River is subject to tidal variations for a distance of close on 100 miles from its mouth, where the first rapids are found. The river banks are formed by low, alluvial mud flats entirely covered by forest. The first sand dunes, which are also covered with dense vegetation, rise 25 miles from the sea and extend some 50 or 60 miles, when higher hills and rock formations make their appearance. The mud flats present a somewhat higher bank or dam bordering the river ; on this all the settlements are placed.

The flats tend to get lower as one proceeds from the river bank towards the foot of the sand dunes, where extensive forest swamps are usually to be found. Some of these swamps are subject to regular tidal invasion from the river ; their waters are limpid, soft, dark brown in colour, and very acid (pH 4 to 5). They are very poor in algae and other vegetation ; the naked, black submerged trunks and limbs (Tacobas) have a characteristic charred appearance; planktonic life also appears to be remarkably scarce.

Acid, peaty waters of this description form a very large proportion of all surface waters in the interior; they appear to be unsuitable for the breeding of *A. darlingi* as we have never found them harbouring larvae of this species.

In some localities, white water springs exist at the foot of the sand hills; in the absence of direct communication with the river or with brown water creeks, clear white water swamps are formed; such waters are only slightly acid, and sometimes neutral in reaction (pH 6 to 7). Vegetation of all kinds is here more abundant, and green algae are frequently noted, covering the submerged logs. These white water swamps are favourite breeding sites of *A. darlingi*; being permanent they are particularly dangerous, and in their neighbourhood we have found this species all the year around (Figs. 1 & 2).

During the heavy rains, from May to July, extensive rain water swamps collect in low places not subject to tidal invasion; these too form suitable breeding sites for *A. darlingi*. Finding the larvae is a labourious task as their dispersion is very great. When the dry weather sets in, most of these rain water collections disappear; in others the characters of the water gradually change through prolonged contact with decaying vegetation, and they become acid and unproductive of Anopheles (Fig. 3).

In conclusion:

The acid dark waters of the tidal rivers and of the black forest creeks and swamps, tidal or otherwise, are permanently unsuitable for the breeding of *A. darlingi*.

Rain water collections and swamps are suitable; they give rise to only temporary or seasonal breeding.

White water seepage swamps and creeks are dangerous and more or less permanent and productive sources of *A. darlingi*.

Besides the physio-chemical characteristics of the waters, other factors influence the breeding of *A. darlingi*.

Fairly large volumes of water are preferred; a fair combination of shade and direct sunlight appears to give optimum conditions; a certain amount of cover in the form of vertical vegetation and floatage are required.

The seasonal factor is also important; breeding is active during the warm weather following the spring and early summer rains; it is scarcely affected by the autumn rains. These, in fact, actually appear to have an unfavourable bearing on the survival of the adult Anopheles from one season to the other; conversely, failure of the November-December rains is often a prelude to an unusual Anopheline and malaria prevalence in the following summer.

Man-made breeding sites are of little moment along the tidal rivers. The Berbice, Pomeroon and Moruka rivers all present similar characters to those we have described on the Demerara.

Figs. 1 & 2.—Typical breeding sites of *A. darlingi* in the interior: white water seepage swamps on the mid-Demerara River. Though apparently completely covered by luxuriant vegetation, the water is exposed to a certain amount of direct sunlight.

PLATE II.

Fig. 3.—Typical breeding site of *A. darlingi* in the interior. Rain water swamps in the mid-Demerara.

Fig. 4.—Abandoned factory sites, with bush covered foundation pits and obsolete canals, form ideal breeding sites for *A. darlingi*.

The mid-Essequebo river is subject to regular, periodic floods; the pulse of these floods is regulated by the rainfall over large tracts of land in the far interior. In these continental areas the distribution of the rainfall is much more characteristic and constant than on the coast: there is a single and well defined rainy season, from May to August.

These Essequebo floods, therefore, as the inland rainfall which causes them, are regularly periodical, reaching their peak in the month of August. During the floods hundreds of square miles of forest are submerged over the 600 mile course of this great river.

The waters of the Essequebo are of a very light brown colour, and their reaction is only slightly on the acid side. These physio-chemical features vary considerably along the course of the river according to the characteristics of the waters of the larger tributaries. The Potaro, for instance, brings to the Essequebo a large volume of dark brown acid water, and the two currents keep separate for some miles after their confluence.

The mid-Essequebo valley is flooded during the local early summer rains. These local rains, conversely to what occurs on the tidal rivers, can have little or no importance as regards the breeding of Anopheles. We found at Rockstone and Butakari that *A. darlingi* made its appearance during and immediately after the floods, when the falling river waters left behind extensive swamps presenting favourable conditions for the breeding of this species. Here again the finding of larvae is a difficult task owing to their wide dispersion.

At Rockstone *A. darlingi* is particularly abundant, as the small clearing, surrounded by forest, offers those conditions of shelter, shade and sunshine which we have already described.

This peculiar complex of conditions which prevail on the mid-Essequebo causes the seasonal incidence of Anopheles and of Malaria to be remarkably regular.

These are the reasons for which the epidemiology of Malaria differs profoundly from one district of the interior to another: in 1926, for instance Malaria prevailed in severe epidemic form throughout the Demerara and other tidal river districts, yet Rockstone and Butukari on the Essequebo, less than 20 miles away, were in no way affected. All these districts experienced that year the same abnormality in the distribution and abundance of rainfall; but while on the Demerara these rains caused the production of a very unusual amount of suitable breeding sites at a particularly favourable season, on the Essequebo these same rains fell on a normally flooded valley, and the seasonal Anopheline and malarial exacerbation followed its usual course, after the flood, quite uninfluenced by abnormal local meteorological conditions.

On the torrential flood rivers, like the Upper Demerara and the Potaro, both of which have dark acid waters, the breeding of *A. darlingi* is essentially related to the rainfall. Where white water creeks and swamps occur permanent favourable breeding sites are provided.

In the Potaro and other gold and diamond mining districts, man-made breeding sites are of particular importance. Old gold pits filled with rain water and other artificial collections, as required for washing and sluicing for gold and diamonds, may all be productive sources of *A. darlingi* in close proximity to the miners' camps.

Bodkin (1921) states to have found Anopheles breeding in discarded tins and other containers in the Potaro district.

Both in that locality and elsewhere in the Colony, and over many years, we have completely failed to substantiate this claim. We have never found *A. darlingi*, nor *A. tarsimaculatus*, or *A. albitarsis* either, breeding in containers of any description ranging from rainwater vats to sardine tins and coconut husks.

Accurate statistics as regards the topographical distribution of *A. darlingi* and of Malaria in relation to the distribution of these various types of surface waters in the interior are not available for the present. It is certain that the incidence of Malaria varies very considerably from one locality to the other. In our own experience, on the Demerara, swamps due to white water springs of low acidity were constantly associated with a high Anopheline incidence and with severe endemic Malaria.

BREEDING HABITS OF *A. darlingi* ON THE COAST.

Surface water conditions on the Coast are varied and different from those of the interior, owing mainly to the very low level of the land, and to its being settled and cultivated.

A very large porportion of the inhabited coastal belt lies below high tide sea level. It is liable, therefore, to tidal flooding from the sea, and seasonal flooding from higher lands farther inland during the rains. From such contingencies, this area is protected by sea defences and back dams. Drainage is carried out by means of a very extensive net of trenches which empty themselves into the sea, sometimes by gravity (during low tide only), more often through powerful pumping stations.

In East and West Demerara efficient sea defences exist along the shore line. Sea water infiltration is very small, being practically limited to leakage from the sea sluices at high tide. In Western Berbice and on the Corentyne, in particular, vast tracks of the front lands are open to regular tidal invasion and salt water finds its way for a distance of some miles inland.

Such tidal invasion, present and past, reflects itself in the salinity of the soils; we find that on the East and West Coast of Demerara, there is only a narrow strip of salt land more or less corresponding to the front pastures, which extend for a depth of one mile from the sea wall at the most.

As one proceeds towards the east the coastal salt land belt becomes progressively wider. In Western Berbice, tidal waters in many places reach beyond the railroad line, and salt soils are found for a depth of two or more miles from the shore line.

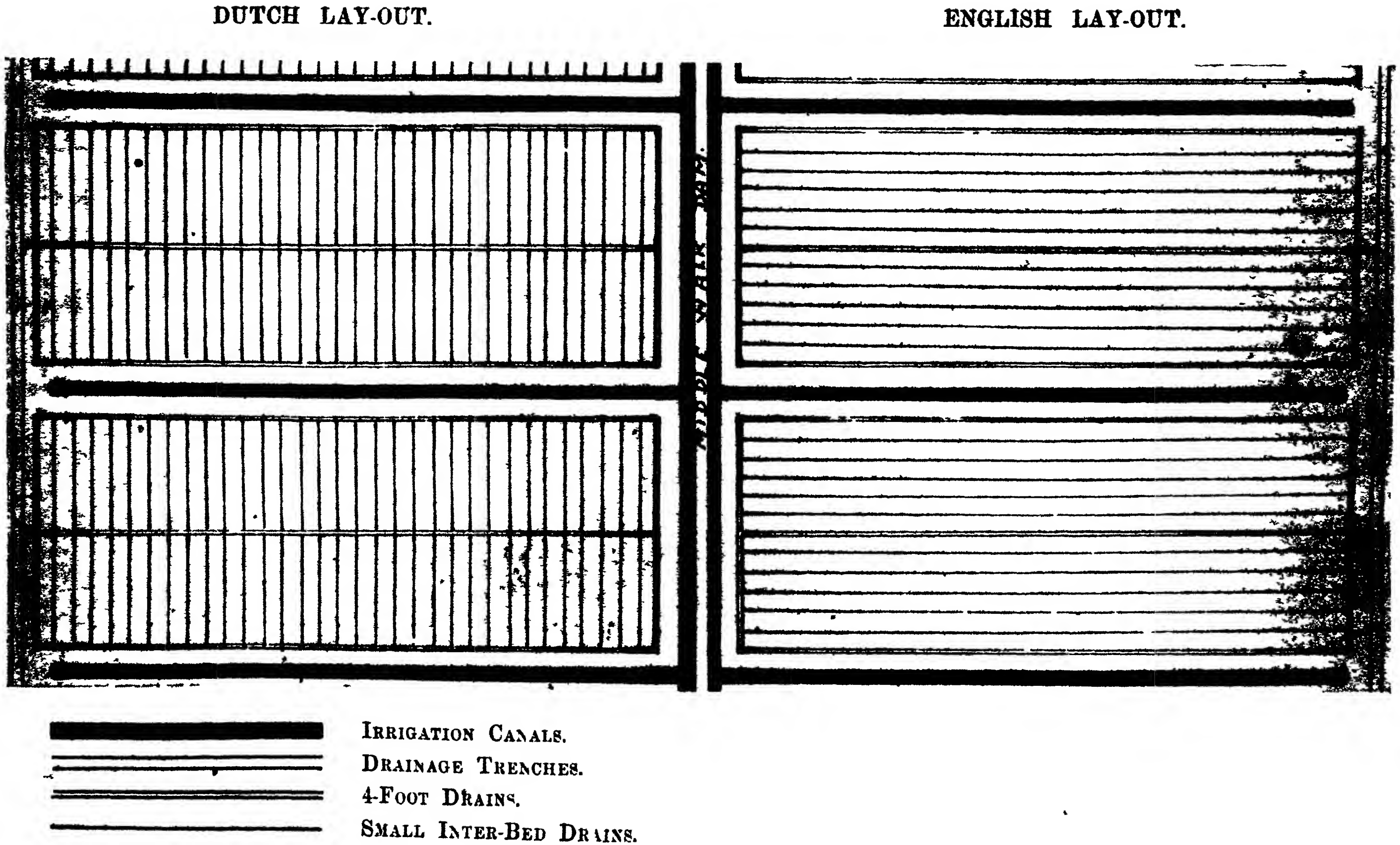

Fig. 5.—Plan of irrigation canals, drains and drainage trenches in a group of four sugar cane fields The disposition of the small drains within the fields varies and the two usual lay outs, Dutch and English, are shown. A square mile of land laid out as above, in 10 acre fields, would include 16 miles of irrigation canals; 4½ of drainage trenches and 45 miles of four-foot drains.

PLATE IV.

Figs. 6 & 7.—Typical breeding sites of *A. darlingi* on the coast. Irrigation canals, sheltered by overhanging cane and covered with floating vegetation in which the larvae and pupae find protection from the attacks of larvivorous fish.

On the Corentyne Coast, salt marshes extend a long way inland and the soils are rich in soluble salt for a very considerable depth. The waters which collect, during the rains, on the extensive savannahs lying aback of plantations Rose Hall, Albion, and Port Mourant, as the dry weather sets in, tend to become too salt for irrigation purposes. This occurs 10 or more miles inland.

We find, in conclusion, that a very large proportion of the surface waters of the coastal front lands are affected by tidal invasion or by contact with soils which are rich in soluble salts. The former are permanently brackish, (Corentyne front land marshes); the latter tend to become brackish during dry weather, by long contact and concentration through evaporation. (Corentyne back dam savannahs and front land rice fields; East and West Demerara salt front pastures).

The salt lands which are subject to regular or occasional tidal influx can usually be recognized by their characteristic vegetation: *Avicennia* (Courida); *Acrostichum* (Bear Grass) *Sporobolus* (Crab Grass); *Pistia* (Water Lettuce) and *Cyperus* (Bizzi Bizzi).

In the inhabited and cultivated belt, natural surface waters are represented mainly by flooded pastures and rain water collections; the great majority of surface water collections are made by man: these include drains and drainage trenches, irrigation canals, canefields in flood fallow, rice fields, ponds and borrow pits.

Our plan (Fig. 5) shows the usual lay-out of irrigation canals, drains and drainage trenches in cane fields. It gives an idea of the magnitude of the canal problem in this country. We have calculated roughly that for every square mile of cane cultivation (10-acre fields) there exist:

16 Miles of Irrigation Canals.

4.5 Miles of Drainage Side-lines.

45 Miles of 4 ft. Drains.

Drains and Drainage trenches rarely harbour larvæ of *A. darlingi* probably in consequence of the small volume of water in the former and the frequent flushing in the water. We have never found this species in the 4-foot and other smaller drains inside the cane fields; small open surface drains, around villages and estate yards, frequently harbour larvæ of *A. tarsimaculatus* and *A. albitarsis*, but only very exceptionally those of *A. darlingi*. In the front lands, many of the larger drainage trenches or "side lines" in dry weather, tend to become brackish owing to leakage through the sea sluices at high tide.

Irrigation canals are, without doubt, the most important from our point of view. They receive their water supply from water conservancies or from creeks lying aback of the cultivation. These canals also constitute the waterway by which cane is conveyed to the factories for grinding. The main canals are known as "middle walks;" at regular intervals these give off blind ending branches or "cross canals." (Figs. 6 & 7.)

The level of the water in the irrigation system is maintained constantly high by pumping. In the main canals, the water is subject to fairly frequent renewal, and it presents the general characters of the inland river and creek waters we have described, but considerable variation exists, according to locality.

We find that in Western Demerara the waters from the Borassiri and Hababoo conservancies and the Camooni Creek are very dark and very acid. (pH 4 to 5.5, sometimes even lower). In East Demerara, the sugar estates receive their irrigation supply from the Lamaha conservancy; these waters are less acid. (pH 5.5 to 6.4 and over.)

Blairmont and Bath receive their water from the Abary: at the pumping station on this river, the pH. ranges from 6.4 to 6.8; the average of 330 pH estimations taken in all sections of the irrigation system of these two estates, at all seasons and over a period of 3 years, was 6.6. Readings under 6 were recorded only on 5 occasions, the lowest value being 5.2; readings over 7 were noted sixteen times with a maximum of 7.2.

Observations carried out at Port Mourant, on the Corentyne Coast, show similar pH values for the irrigation canals, which get their supply from the Canje river.

The sodium chloride content of the irrigation canal waters ranges, as an average, from 20 to 40 milligrams per litre; except in some front land sections in which readings of 30 to 100 milligrams per litre were sometimes noted.

In the middle walks the water is more frequently renewed; in the blind ending cross canals, it is quiescent; during the rains the reaction in the latter canals is often considerably less acid than in the middle walk. In these blind ends, or "bucket heads," floating vegetation such as floating grass (*Paspalum*), water hyacinth (*Pontederia*), *Salvinia*, and our floating mimosa (*Neptunia*), tend to accumulate and spread. These cross canals, overgrown by vegetation and sheltered as they are by overhanging cane, when the pH reaction is above 5.8, are the favourite breeding sites of *A. darlingi*. Variation in pH reaction in these waters, brought about by closing or opening the conservancy sluices, or by excessive rainfall, undoubtedly affects the distribution and intensity of breeding of this Anopheles in the irrigation canals. Larvae are usually absent in canals which are kept free from floating vegetation.

Flooded Fields: Flood fallowing is an important characteristic of the local technique of cane cultivation: after three or four crops have been taken off a cane field a small dam is thrown up around it and it is flooded and left to lie fallow for 6 months to 1 year. This practice has greatly increased the yield per acre and is, therefore, of vital importance to the local sugar industry.

Flood fallowing is also a feature of unusual importance to the malariologist: at any time from one-tenth to one-eight of the cultivated land of an estate is flooded, often in close proximity to estate villages. For the first few months after flooding a considerable amount of fermentation occurs from the submerged

Fig. 8.—Flooded fields lying fallow, when covered with floating and vertical vegetation and favourably may be productive sources of *A. darlingi*.

Fig. 9.—Rice fields situated beyond the salt coastal front lands, and sheltered by trees and scrub, are breeding sites of *A. darlingi*.

PLATE VI.

Fig. 10.—Open, windswept rice fields in the salt coast front lands are favourite breeding sites of *A. tarsimaculatus*, but only very exceptionally harbour *A. darlingi*.

cane tops and stumps ; the water is brown and has a distinct odour ; vegetation is scarce. At this stage we have never found flooded fields harbouring Anopheline larvae.

After three or four months vertical and floating vegetation appears and rapidly spreads (mainly *Paspalum*, *Pontederia*, *Salvinia*, *Neptunia* and *Limnocharis*). The waters become clear and their pH ranges usually from 6.2 to 6.8 ; the rains have an important part in bringing about this change in the characters of the waters. At this stage flooded fields often become very productive sources of *A. darlingi*. In some localities we have completely failed to find larvae of this species in spite of apparently favourable conditions. Abnormally high salinity of the waters (100 milligrams per litre) or lack of shelter and general situation and exposure of the field sometimes explain these negative findings (Fig. 8).

Rice Fields : Rice is cultivated throughout the coast, around and in the immediate neighbourhood of most villages, on sugar estates and on some of the creek savannahs. According to locality this cultivation is dependent on the rainfall, on the irrigation system of sugar estates or on the seasonal creek floods. Planting is done between March and June ; the fields are under water from May to August ; reaping takes place in September and October. Usually only one crop is planted and after reaping the fields are left to themselves till the following season, most of them being flooded during the Autumn rains.

When the growth of the rice is well advanced rice field waters are usually clear and light brown in colour ; pH ranges from 6 to 7 ; their content in soluble salts varies within wide limits : in most front land fields the sodium chloride content is frequently well above 100 milligrams and sometimes amounts to several grams per litre ; further inland it is usually low, 15 to 50 milligrams.

The full grown rice plant offers good protection to mosquito larvae at its base, in between the stems. Larvae of *A. tarsimaculatus* are practically always present and abundant. *A. albitarsis* occurs when the salinity is low. Under the latter conditions *A. darlingi* may be found, sometimes in large numbers, when the rice fields are sheltered by surrounding trees and vegetation which form wind-screens and offer a certain amount of shade. This species is practically never found in the rice fields of the open, windswept front lands as exist on the East Coast, north of the sugar estates and, more particularly, in Eastern Berbice. (Figs. 9 and 10).

Borrow Pits : These exist in great numbers the length of the coast along the rail and public roads ; scores are dug every year for the preparation of burnt earth. Fortunately they are nearly all located in the windswept, salt front lands and though very productive of Culex mosquitoes and *A. tarsimaculatus* they form unlikely breeding sites for *A. darlingi*. During heavy rains and where suitable shelter exists borrow pits also may become dangerous breeding sites for *A. darlingi*.

On sugar estates abandoned factory sites, with bush covered foundation pits and obsolete canals, often present excellent conditions for the breeding of the dangerous malaria carrier. (Fig. 4).

Ponds : These are particularly common in villages where, in the absence of irrigation canals, they are used for storing rain water for domestic purposes. *A. tarsimaculatus* is nearly always present ; *A. darlingi* may occur when the water is clear and sweet and if suitable shelter exists.

Flooded Pastures : Beyond the coastal salt land belt, flooded pastures when sheltered and rich in vertical and floating vegetation, are dangerous; the same may be said of the bush covered rain swamps which collect on sand-reefs and other abandoned lands.

In the salt front lands, where *A. darlingi* is usually not found breeding, this species may occur, sometimes in considerable numbers, during heavy and persistent rains which affect both the physio-chemical characteristics of the waters and atmospheric humidity.

From this brief review it will be noted that a very large proportion of the water collections which favour the breeding of *A. darlingi* on the coast are *man-made* and that they are essential and, therefore, unavoidable factors in the basal agricultural industries of the Colony, sugar and rice.

Most of these surface waters, (irrigation canals, flooded fields and many rice fields) are not dependent on seasonal factors such as rainfall and floods ; they are permanent, and as such offer, the year around, favourable conditions for the breeding of Anopheles. Though season evidently still plays an important part in the intensity of Anopheline breeding, we have found that *A. darlingi* on the coast can be collected, both in its adult and developmental phases, throughout the year. In the interior we observed this to occur only in proximity of white water seepage swamps which offer permanent and suitable breeding sites. This is evidently the reason why on those parts of the coast which are subject to endemic malaria, the seasonal incidence of this disease is very much less clearly defined than in the interior.

Both in the interior and on the coast our findings tend to demonstrate that the breeding of *A. darlingi* is restricted to certain types of surface waters. This species has a preference for water collections of considerable size. There evidently exist certain characteristics of surface waters and soils which are not congenial to this species and which, therefore, tend to limit its dispersion. We believe that the following are some of such limiting factors.

Reaction of Surface Waters : *A. darlingi* is only exceptionally found in waters with a pH value under 5.8; the optimum range is from 6.2 to 6.8.

At Cane Grove, in spite of general conditions which would at first lead one to expect the existence of severe malaria, we have found this disease only mildly endemic (spleen rate : 16.1% and parasite rate 15.9% in 1937). The soil in this

locality is exceptionally acid. In April this year we found the pH of irrigation canal waters ranging from 5.2 to 5.4; in some stagnant drainage trenches we obtained readings as low as 3.5. We failed completely to find adult *A. darlingi* in the houses or its larvae in any of the surface waters, in spite of the fact that this species was at that time abundant all along the East coast.

At Wales, an estate with a particularly bad malarial reputation, the incidence of this disease has shown a very distinct drop since 1934, coincidently with the opening of a canal from the Camooni Creek to the Hababoo conservancy which supplies the irrigation canals of this estate. Camooni waters are very acid (pH 4.26 to 4.47 in April 1938). In August 1937, (with the Camooni and Hababoo sluices open) in a search lasting several days, we completely failed to find larvae of *A. darlingi* in the irrigation canals of this estate (pH 5.2), but we found them common in flooded fields (pH 6.2 to 6.6). In April this year, during heavy rains, with all the conservancy sluices shut, we found only a few larvae of this species at the bucket head of a cross canal (pH 5.8); at the same time in flooded fields and in the same locality (pH 6.6) larvae could be collected at every dip.

In the interior a very large proportion of surface waters are strongly acid and we believe that from a malariological standpoint they are not dangerous ;we have, in fact, successfully controlled productive breeding sites by opening them up to tidal invasion by acid river and creek waters.

Salinity : *A. darlingi* is only rarely found in waters which contain over 100 milligrams of sodium chloride per litre. On the Berbice estuary in three years we made only one such observation, the sodium chloride titre being 184 milligrams per litre.* The usual range is 20 to 60 milligrams, but in the laboratory we have raised this species, from ovum to adult, in water containing 300 milligrams per litre.

On the coastal front lands and on the Corentyne in particular very extensive tracts of marshes are permanently and definitely brackish ; other vast areas of surface waters become so in the dry weather through contact with salt soils and evaporation. Most of the rice cultivation in the Berbice front lands falls in this group. All such waters, as not productive of *A. darlingi*, can be overlooked in the carrying out of an anti-malarial campaign.

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*Since the present article was written, we have found *A. darlingi* breeding in water with a sodium chloride content of slightly over 3 grams per litre, at La Bonne Intention, on the East Coast.

Larvae and pupae were found in a canal communicating with the dammed off terminal portion of the main middle walk which, during the rains, is used to blow off to sea, through a sluice, excess water from the irrigation system.

When this canal is stopped off from the main irrigation system as at present, at high tide salt water leaks through at the sluice gate.

We have found that the salinity in this canal and at the same spot where the larvae were discovered varied within wide limits, in the course of only 5 days the sodium chloride falling progressively from 3.650 to 0.400 milligr. per litre.

The breeding of *A. darlingi* in water of such high salinity certainly remains a very unusual occurrence.

Atmospheric Humidity: This too we believe is an important factor which limits the range of *A. darlingi*: the adult of this species is very susceptible to desiccation and exposure to the strong coastal breeze rapidly kills it.

Some localities, though presenting apparently ideal surface waters, under ordinary meteorological conditions are practically free from *A. darlingi* and from endemic malaria. Plantation Bath is a good example; the canals and flooded fields of this estate receive their waters from the same Abary pump which supplies Blairmont, a notoriously malarial locality. We studied these two estates comparatively for three years (1934-1936) and came to the conclusion that the drier atmosphere at Bath was responsible for the absence of *A. darlingi*. It should here be remembered that this mosquito is a strict night flyer and mainly a native of equatorial forest regions where the night atmosphere is more or less constantly saturated with moisture.

We attribute the habitual freedom of the Corentyne coast from *A. darlingi* and endemic malaria to a relatively higher atmospheric dryness and to the salinity of the surface waters and soils throughout the inhabited belt.

The well defined seasonal malarial epidemics which have occurred at Bath and on the Corentyne coast following the very exceptionally wet seasons of 1937 and 1938 tend to confirm our views.

The factors which we have listed as controlling influences on the breeding, and therefore on the dispersion of *A. darlingi*, exercise no similar influence on the other local common Anopheles. This is particularly the case for *A. tarsimaculatus* which presents the most remarkable latitude in the choice of its breeding sites: we have found this species breeding actively and evidently flourishing in waters the pH of which ranged from 4 to 7.8 and the sodium chloride content from 0.005 to 28 grams per litre. With such extraordinary adaptability practically *all* surface waters of this Colony are suitable for this species if cover is provided in the form of vegetation or floatage for the protection of the larvae from their natural enemies. Evidently the control of this species on the coastlands of Guiana would be a very arduous, not to say hopeless, task. Fortunately this control is not required as this species locally does not act as a carrier of Malaria.

We have thus concluded the study of the entomological aspects of the local malarial problem in its principal lines.

Our findings are encouraging as only a single kind, out of the several local Anopheline species, emerges from this investigation definitely indicted with the transmission of malaria in this Colony. We have also found that *A. darlingi* has certain selective breeding habits and that its range of flight is equally subject to certain limitations.

These findings infinitely simplify the malarial prevention problem, for they allow us to direct our effort against well defined objectives with a good knowledge of the vulnerable points in the enemy's defences.

(*To be Continued*)

THE GEORGETOWN BOTANIC GARDEN.

SOME NOTES ON ITS EARLY HISTORY.

BY

E. B. MARTYN, B A., A.I.C.T A.

Government Botanist & Superintendent, Botanic Gardens.

In the latter part of the 19th century, the formation of Botanic Gardens or Botanic Stations was encouraged throughout the Colonies. In the West Indies the Gardens at St. Vincent, the forerunner of them all, and those at Trinidad, were already long established. The object of such gardens was primarily to encourage the introduction of new crops, and Sir Joseph Hooker, Assistant Director and later Director of Kew from 1855-85, took a keen interest in them. They were in many cases, including British Guiana, the forerunner of later Agricultural Departments and Experiment Stations.

It is not quite clear who was chiefly responsible for the initiation of the Georgetown Garden, but in 1878 the Combined Court voted a sum of $240,000 for the establishment of a Garden that was to be both a recreation ground for the citizens of Georgetown as well as a site for the experimental cultivation of plants. The area chosen for the new Garden, some 163 acres in extent, was part of the back lands of the old Pln. Vlissengen, and was purchased for a sum of $52,140.95. It was selected as being close to the city, its position in the angle of the Lamaha Canal also being advantageous for purposes of irrigation. Apart from this however, the site had little to recommend it, as the land had been abandoned for many years, and was trampled by cattle and largely overgrown by bush. In addition the drainage trenches were choked up, and the removal of earth from various places had added further to the swampy nature of the ground.

The task of designing the new Garden was entrusted to Mr. Prestoe, then Government Botanist in Trinidad, who visited the Colony for this purpose in the Autumn of '78. On seeing the site he was immediately struck by the two avenues of Oronoque trees, relics of the old estate, the one running down the line of the middle walk, from front to back of the estate, the other crossing the former at right angles, near the front of the estate. On these two avenues, which were to be left almost untouched, the plan of the new Garden was based.

Mr. Prestoe's plan was forwarded to the Governor, (C. H. Kortright, Esq., C.M.G.) at the end of November, 1878, with a request that the area destined for the nursery should be temporarily fenced as early as possible, and got ready for the raising of young trees and shrubs. The Garden was to be under the management of a Board of Directors, and Mr. Waby, who had been Assistant Gardener in Trinidad, was appointed to be Head Gardener and to supervise the carrying out of the plan until the arrival of the new superintendent, Mr. G. S. Jenman, from Jamaica, where he had been in charge of the Castleton Garden.

Mr. Waby and his family arrived in the Colony at the end of December, '78, bringing with them a number of young plants from Trinidad, and Mrs. Waby has left a good description of the conditions met with on their arrival. (1) After being taken by Mr. Tinne, Chairman of the Directors, to see the site of the new Garden, Waby returned to his hotel horrified at the morass which he was expected to tackle, and wished very much that he had stayed in Trinidad. It was a further disappointment to him that the Gardener's house which he was expecting had not even been begun. For the first three years he and his family lived in a small house (the old Government Laboratory) at the top of Brickdam which for some time also provided nursery accommodation, potting sheds, and storage room for the Garden.

The first essential of the Garden was to obtain proper drainage, and to build up the main avenue. The whole level of the front Garden, which was to be tile drained, needed to be raised, the old middle walk navigation trench had to be filled in, and side lines dug. Prestoe had planned a series of lakes which were to give drainage and provide earth to 'fill in dips and make undulating banks.' The roads, he considered, if built up and 'round-ridged', using the subsoil mud, would need very little surfacing (*sic*). As work proceeded, however, it was found that more lakes than originally planned for were required, first to raise the level of the ground sufficiently quite apart from making undulating banks, and also to provide large quantities of burnt earth to cover the avenue and the side paths. The transport of the earth was facilitated by the use of a portable railway, first hired from Booker Bros., and later purchased.*

Work on the new Garden was begun on January 2, 1879, and the first meeting of the Board of Directors was held at the Royal Agricultural & Commercial Society's rooms on February 1. The Honourable J. E. Tinne was Chairman, the other directors being the Honourable H. T. Garnett, the Honourable A. F. McFalman and W. H. Campbell, Esq. (the last named eventually became Chairman in January, 1883, and always took the greatest interest in the Gardens until his death in December of the same year). At the meeting Waby read his first report, and it was decided that each director in turn would supervise the work for one week. It may be noted that at most meetings in the ensuing years not more than two Directors were usually present.

The new Government Botanist and Superintendent of the Gardens, Mr. G. S. Jenman, arrived in the Colony in August, 1879. Almost immediately after his arrival he set out on a collecting expedition up the Corentyne River with Mr.

(1) Eleanor S. Waby 'Forty Years' Life in Tropical Gardens', *Timehri*, Vol. III, 3rd. series No. 2, 1915, p. 285.

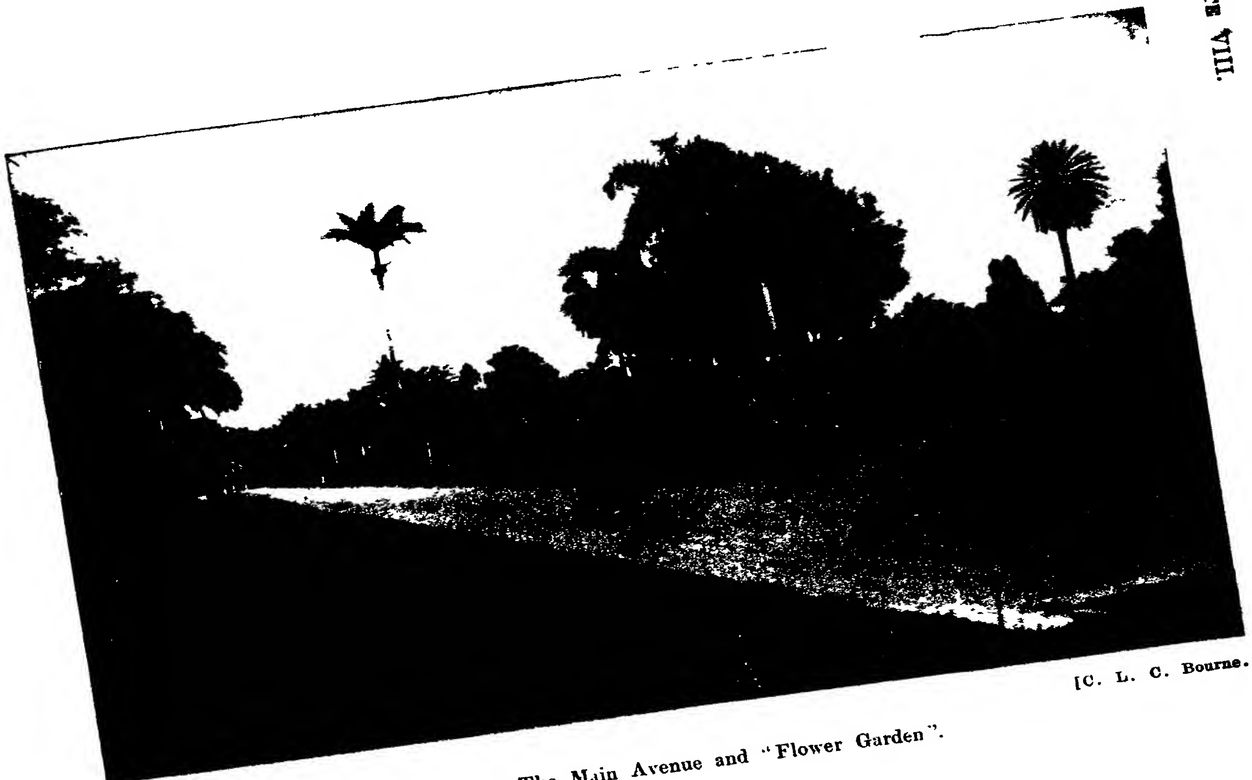
* This railway had a long and varied history. In December, 1883, when no longer required at the Gardens, it was temporarily lent to the Public Works Department, and no further mention of it appears for 34 years. In 1917 however, the late Sir John Harrison, Director of Science and Agriculture, having presumably found the letter relating to the original loan in an old file, wrote to the Public Works Department and asked for the return of the railway belonging to the Botanic Gardens, and which had been temporarily lent! The Director of Public Works replied however, that no trace of it could be found, and that it had probably been used on the sea defences.

PLATE VII.

Photo] [C. L. C. Bourne.

FIG. 1.—The Entrance Gates and Lodge to-day.

PLATE VIII.



Photo] [C. L. C. Bourne.

FIG. 2—The Main Avenue and "Flower Garden".

im Thurn, who had already arranged to make a journey in this area in his capacity as Curator of the Museum, and it was not until November that Jenman returned to town and took up his duties at the Gardens. From that time until the day of his death—rather more than twenty-two years later—his energy and keenness provided the main driving force to complete the laying out and manage the subsequent maintenance of the Gardens. Not many people in the Colony today remember Jenman well, but from the records of his correspondence and minutes it is possible to form a picture of him. A man of strong character and quick temper is revealed in the copies, in his own hand, of a number of acrimonious missives, both to the Directors and the Government Officers to whom he was responsible, and also to his subordinates; but these records also make plain his great insight into all matters horticultural, and his constant wish that the Garden should continue to improve and fulfil all of the objects for which it was laid out. After he had laboured for two years, the Directors and himself received the highest praise from Sir Joseph Hooker on the progress made, and throughout his career Jenman received a number of well merited commendations on his work, both as Botanist and Superintendent of the Gardens, from those best qualified to judge in either sphere.

One of the matters requiring early attention was the housing of the Superintendent and the Head Gardener 'on the spot'. On his arrival Jenman took up residence at the old Tower Hotel, and within a month or two his claims for cab hire to and from the Garden were already involving him in arguments with Government. Waby, as we have seen, was temporarily housed in very inadequate quarters at the top of Brickdam. It had been originally intended to build the Head Gardener's house on the piece of land opposite the Garden, now occupied by the Department of Agriculture, but this idea was abandoned, and it was decided to build both houses inside the Garden. The Wabys' house was finished at the beginning of 1882, and they moved into it in February. A bungalow, built at ground level, with more attention paid to its outward appearance than its internal accommodation, it was a most unhealthy and uncomfortable residence. However, it underwent a number of subsequent changes, which included raising it on pillars, and altering the roof, which had originally sloped to within 3 feet of the top floor. Today it is used as the Chemical Laboratory of the Department.

The building of the Superintendent's house (now the residence of the Director of Agriculture) involved Jenman, the Directors and the Public Works Department in prolonged controversy. First there were delays in acceptance of the plan, then in erection of the building, upon the completion of which Jenman demanded a number of alterations, only some of which were provided. Finally, though the building was finished in December, 1882, and the Government Botanist's office on the ground floor was used from that time, Jenman could not or would not take up his permanent residence in the building until the middle of 1883, as prior to this there was no proper bridge giving direct access to the house and the only other means of approaching his new home was across the still unfinished Garden, from the main entrance gates of the latter.

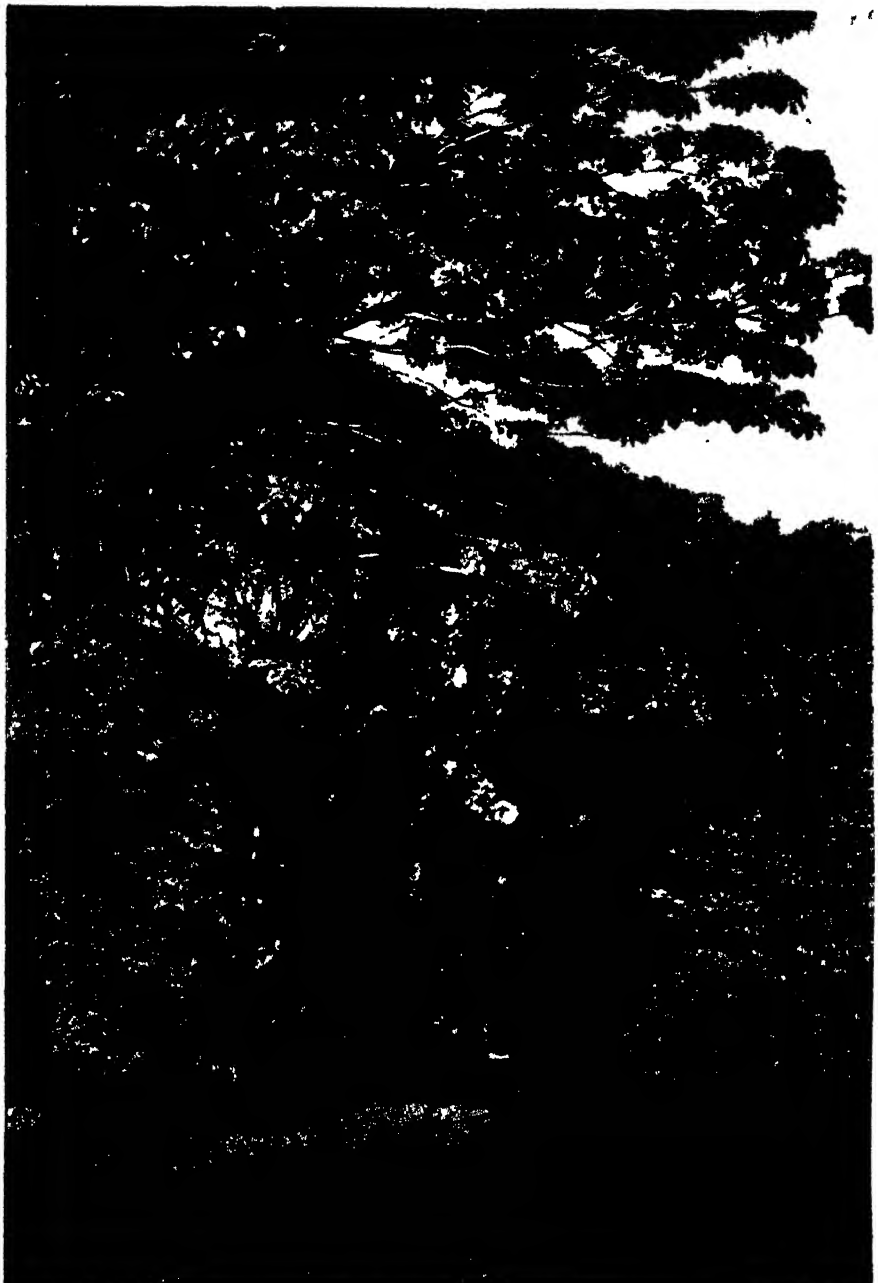
In the meantime, other construction work in the Garden had been going on. The entrance gates, decided upon in February, 1880, were ordered from England, erected in January, 1881, and have not been changed since. The Lodge beside the gates was also built in 1880, with a front room where the Directors could hold their meetings, and accommodation for a watchman. It originally had a shingle roof, only replaced by iron sheets in 1932. This building was designed by the Honourable J. Brummell, Sheriff, who had become a Director in February, 1879, and in May succeeded Mr. Tinne as Chairman, and in whose office in Brickdam Directors' meetings were held from that time until the Lodge was ready. Mr. Brummell was one of the keenest of the Garden's early supporters, and his death in December, 1881 was a great blow. The present Bandstand was eventually erected to his memory in 1889 and is certainly a more worthy memorial than the drinking fountain first suggested as suitable for this purpose. (It is of interest here to note that permission for the Militia Band to perform in the Garden was first obtained in May, 1883).

But to return to the Garden itself, the drainage and irrigation of the land provided a series of difficult problems. As regards drainage, it was decided that the Front Garden—some 20 acres in extent, should be tile-drained. Large underground drains made with concrete slabs were laid down on each side of the main avenue, and into these emptied the water from 40,000 feet of tile drains. The latter were made at Pln. Montrose and laid in 1879 by Chinese labourers from the estate, who were experienced in work of this nature. Five years later they had become choked, and had to be cleaned, work again carried out by the Chinese, and they once more had to be cleaned in 1889. Eventually it was realised that such a form of drainage was not suitable for local conditions, and after Jenman's death the open drains at present in existence were made.

To get the water away from the land, the Croal Street trench, which formerly provided the only outlet, was not sufficient, and a tunnel was made under the Vlissengen avenue to connect the north side line to the North Road trench, the responsibility for deepening this and the South Road trench eventually being amicably settled with the Town Council. Drainage however continued to be poor, especially during wet weather, when the ground remained water-logged for days on end, and in consequence the Superintendent's and Gardener's houses became most unhealthy. In 1889, a drainage pump was put in at the north western corner to drain the Flower Garden; it was transferred in 1899, to drain the Experimental Fields,* and later removed by the Public Works Department.

Irrigation received early attention, and in 1882 a tall iron tank and pumping engine were erected, and connected to a series of pipe lines throughout the front Garden. Subsequently, it was found difficult to obtain sufficient pressure in the tank, and irrigation by this method was never very successful. In later years, open irrigation channels were used, and recently the original pipe lines, the majority of which were found to be still in sound condition, have been in great part connected to the town water supply, whereby a suitable pressure for

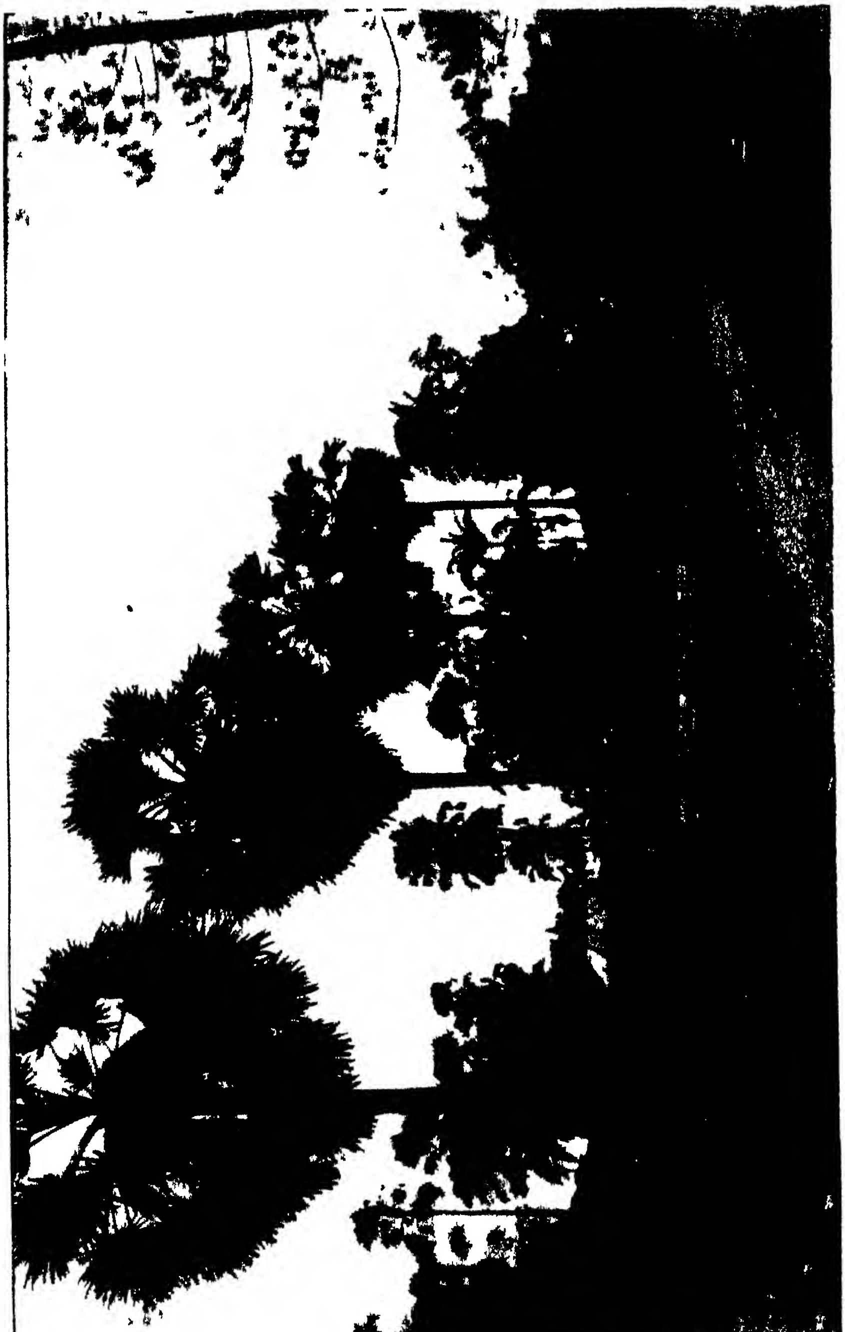
*See footnote on page 211.



Photo] [Dr. B. E. Dahlgren.

FIG. 3.—The "Oronoque Avenue," now the Central Avenue through the Park Lands.

PLATE X.



Photo] [C. L. C. Bourne.

FIG. 4.—The Bandstand and Flower Garden"

watering is obtained, and this can be much more effectively carried out. The irrigation tank was dismantled and removed in 1936.

The first 18 months in the life of the Garden was entirely taken up with preparation of the land, and the work was somewhat hampered by very wet weather in 1880. Planting, however, began in the middle of the latter year, the oval, in the middle of the avenue, being the first area planted, after which followed the border along the Vlissengen Road, the ground about the lodge (including the Eucalyptus trees which stand behind it today) and the line of Samans along the northern side of the Garden. As early as 1881 Jenman remarked on the surprisingly rapid growth already made by the majority of the new trees. Before the planting of any of the borders, however, the first part of the Garden to be laid out had been the nursery, which was divided into squares, surrounded by a Cherry Hedge (which is there still) and provided with a temporary progagating shed, which remained until 1894, when it was removed, having been replaced in 1890 by a more permanent erection, part of which remains today. The sale of plants began in 1883. Amongst early plant introductions raised were a number of grafted Mangoes and Litchees, obtained from Calcutta on an immigrant ship, and some canes from Honolulu, several of which survived the 2 months' journey despite the fact that they had been packed dry, with the ends sealed, and formed the basis of the large collection of Sugar Canes that were later used for Jenman and Harrison's* researches on this crop.

The plan of the Garden included the Vlissengen Road Avenue, which was to be planted with Saman trees that had been raised at Waby's house. The construction of the avenue entailed considerable labour, as to give it the necessary breadth the old trenches bordering the road had to be filled in and new ones dug further out. This was part of the first work undertaken, though the avenue was not planted until January, 1881. Some difficulty was experienced as the young trees grew up to prevent their leaning with the prevailing wind, and their appearance even today shows that in not every case was this tendency overcome.

The Central Avenue to the back of the Garden, or Oronoque Avenue as it was then called, was planted in 1881, shortly after the Vlissengen Road Avenue. The Directors originally decided to make this main avenue representative of the principal forest trees of the Colony, but as many of these would not thrive on the Coastland, and as another alternative, namely a selection of fruit trees, would have proved too great an incitement to petty pilfering, it was finally arranged to use a selection of large growing tropical trees, the majority being American species. The lower half of the Avenue was made 20 feet wide, and bordered by trenches which were to act as reservoirs in dry weather and take off the surface water after rain. The upper half was originally only 10 feet in width, and the

*Mr. Harrison as he then was, arrived in the Colony in 1889 as Government Analyst in place of Mr Francis who had died. The first cane cultivation was carried out on an area of 4 acres, outside the south-eastern corner of the original Garden, and now forming the southern field of the Experiment Station. The field of the present Station immediately south of the avenue was taken into cultivation in 1899 when the work on cane was extended. The field to the north of the avenue was cleared and taken in for rice cultivation circa 1903.

ground through which it passed was left for some years in its original wild state, with the idea that it might be used for planting trees suitable for timber or fire-wood. This idea was never carried out, and eventually it was taken into cultivation to form the experimental station. In the early days of the avenue, the Oronoque trees (*Erythrina glauca*) formed its chief feature, though they have gradually fallen, until today only two or three creeper covered relics are left. In the drought at the end of 1887 the flowering of these trees was a remarkable spectacle, as they were crowded with blossom, and at the same time all the foliage was shed, which is not typical of this species of *Erythrina.*

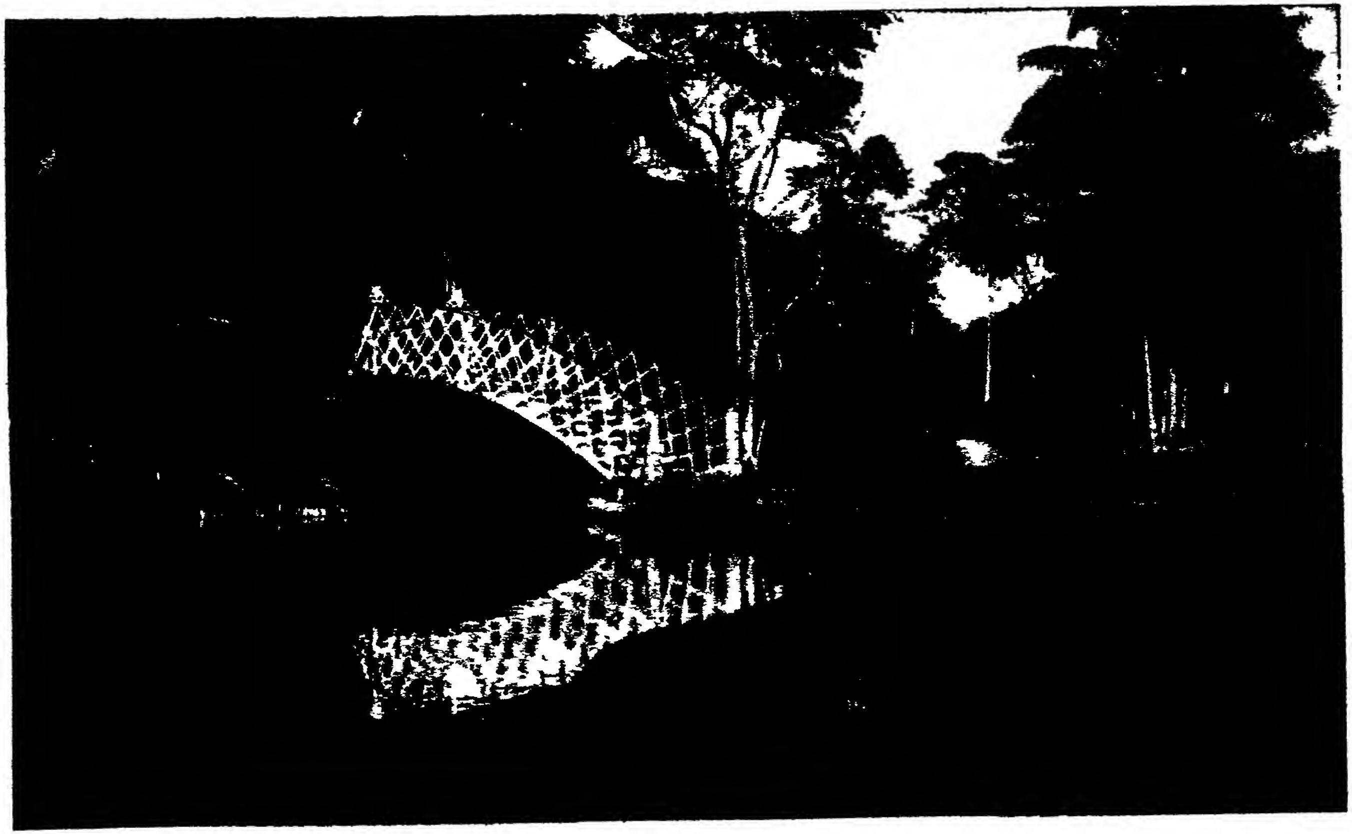
Beside the Central Avenue, the two Serpentine Roads were laid out, but were not surfaced, or connected by bridges to the main avenue for some years. The Hippanai Trees (*Parkia pendula*) originally planted along them, did not prove a success, and the Pithecellobiums and Palms bordering these avenues today were not planted until 1888.

In addition to these avenues within the Garden however, it was originally intended to make a drive (36 feet was the width first suggested) around the outside of the whole area, and with this end in view the D'Urban Park gap was extended in 1881, chiefly with earth from the new south side line.* After this the next operation was to have been the making of a drive on the northern side, bordering the Lamaha Canal, but owing to the difficulty of raising the surface of this road to be high enough above the level of the Lamaha in wet weather, the idea was never carried out, and the North drive was not built, this strip of land being planted instead with shrubs and trees. In 1882 a strip of land north of the canal was bought from Pln. Bel Air, and planted with quick-growing trees to form a shelter belt for the Garden, which land was subsequently given to the Town Council in 1925 and cleared to form the site for the new Water Works and Pumping Station Buildings.

By October 1882, the original amount of $240,000 voted for the establishment of the Garden was nearly finished, and Government apparently considered that the new venture was proving rather unduly expensive, for the Directors were asked to curtail expenditure and told that in future the Garden must be run on an annual maintenance vote. When asked however, what he considered the expenditure would be in 1883, Jenman's estimate totalled $23,432 !

In May 1883 Jenman began to attend Directors' Meetings regularly, and in June the Directors were relieved of the financial business of the Garden and Jenman had to requisition Government for money and account to them for its expenditure in the usual manner of a Government Department, though the Directors still acted in an advisory capacity. The relative relationships between Government, the Directors and the Superintendent appear to have been rather

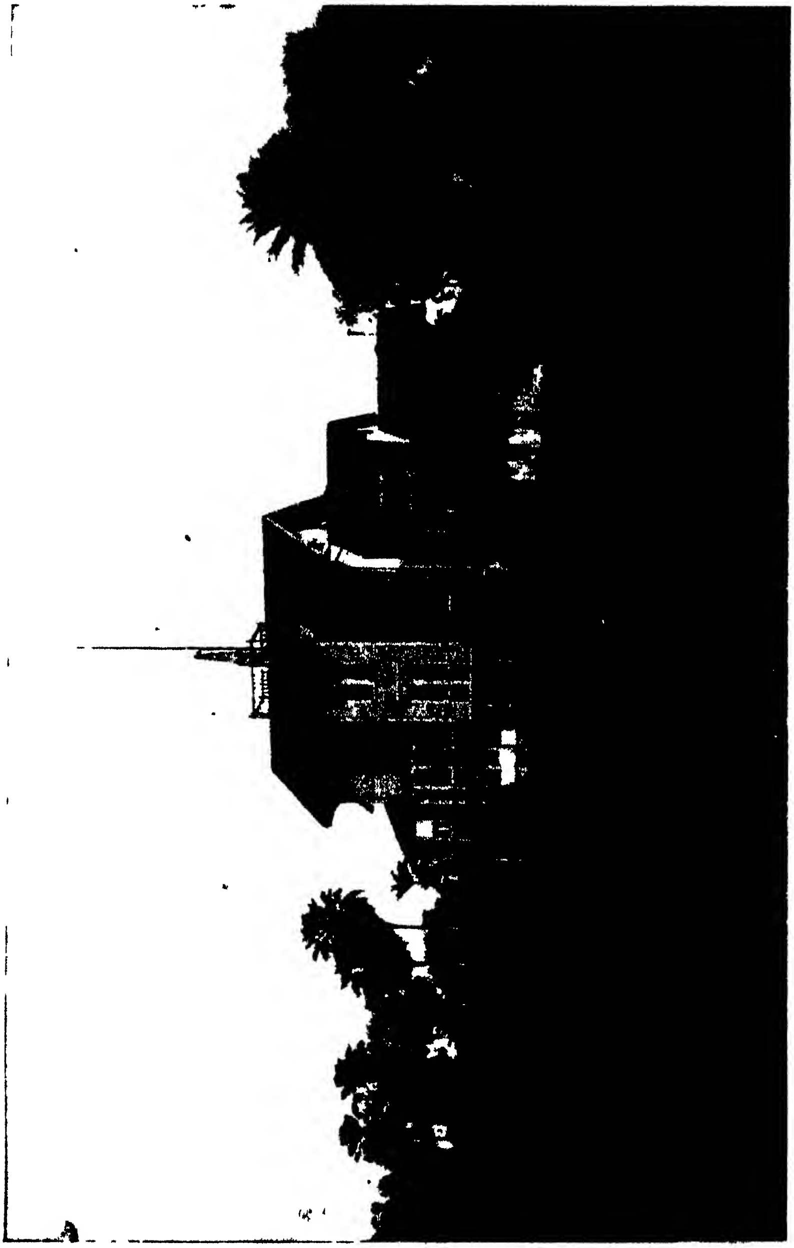
*It may be noted that the D'Urban Park Race Club Stand was from the beginning left outside the Garden, cut off by a detour in the side line trench as it exists today. Other stands belonging to the club, which stood formerly on the land leased to the Directors, were removed at their request when the land was taken over.



Photo] [C. L. C. Bourne.

FIG. 5.—The Iron Bridge over No. 2 Lake.

PLATE XII.



Photo] [C. L. C. Bourne.

FIG. 6.—Jenman's House and Herbarium, now the residence of the Director of Agriculture.

vague, but when in 1888 the Directors were informed that they were to have no further control over the Superintendent or the finances of the Garden, the Chairman and two other Directors threatened to resign, and the two latter in fact did so. By this time however, Directors' meetings were only held at very infrequent intervals, and in May, 1892, appear the last recorded minutes of a meeting.

As commonly occurs with concerns of this nature, the amount of money provided for the upkeep of the Garden was often less than the ambitions of those responsible for its appearance demanded. Thus in 1886, when a further loan of $20,000 for the completion of the Park Lands area was exhausted, and no provision made for their upkeep, Jenman was horrified to discover, on his return from leave, that the vote for maintenance of the whole Garden had been cut (by a majority of 1 on the division) from $10,000 to $7,500. He had previously stated that $10,000 was inadequate and considered $15,000 the minimum necessary for maintenance. As a protest, declaring at the end of the year that he could not maintain the Flower Garden with the money available, he discharged all hands during December and left the area unattended, and in 1887 allowed the appearance of the Garden to become so bad that a reprimand was received from the Governor. In the ensuing year however, the vote was increased by $2,000.

Glancing through the correspondence, minutes of Directors' meetings, and other papers concerning the Garden, of which copies remain, we get some interesting and amusing insights into the affairs of sixty years ago. There is a note on the price paid for labour in August '79—Foreman 64cents per day, Shovelman 32–40 cents, women 24–32 cents. In May '80 a clock and bell were requisitioned, to ensure more punctuality over working hours. In '81 the closing of the Garden to visitors after the official hours was strictly enforced. In '82 we find one of the Directors involved with Jenman in violent conflict, conducted mostly with the pen, over a matter of some coffee seedlings which the former had obtained from the Garden while Jenman was on leave at a price which the latter considered too low. In the end, the Director in question resigned, and after a series of parting shots from all concerned, the action was broken off. In '83 Jenman was given a riding mule to use in the Garden and Waby had already been supplied with a pony in 1879,* but the former's subsequent application for a horse and waggon was refused. In 1883 also there were constant bickerings with the Public Works Department concerning the engineer in charge of the irrigation engine. This individual, described as a Petty Officer of the Public Works Department, was under the latter Department's orders and would brook no interference from the Garden Superintendent. The result can be well imagined.

* This animal performed yeoman service for Government until June, 1899, when Waby reports that 'on Tuesday last it fell beneath me, all of a heap', and asks for another one, enclosing a certificate from the Government Veterinary Surgeon to the effect that the pony was suffering from 'senile decay'.

In June '83 the Georgetown Bicycle Club applied for leave to make a track 250 yards round in the Garden, for use of members. Though the application was at first refused, in the following year it received the Directors' support, but nothing seems to have come of it. In '84 the Tramway Company applied to run their vehicles from the terminus in Croal Street up to the end of that street and some 400 yards along the southern dam (*i.e*, the D'Urban Park Gap), and this being objected to, applied in '85, to come to the Garden main entrance. This also was refused, though it was suggested they might stop in the Vlissengen Road opposite the top of Charlotte Street, but the proposal was apparently not followed up.

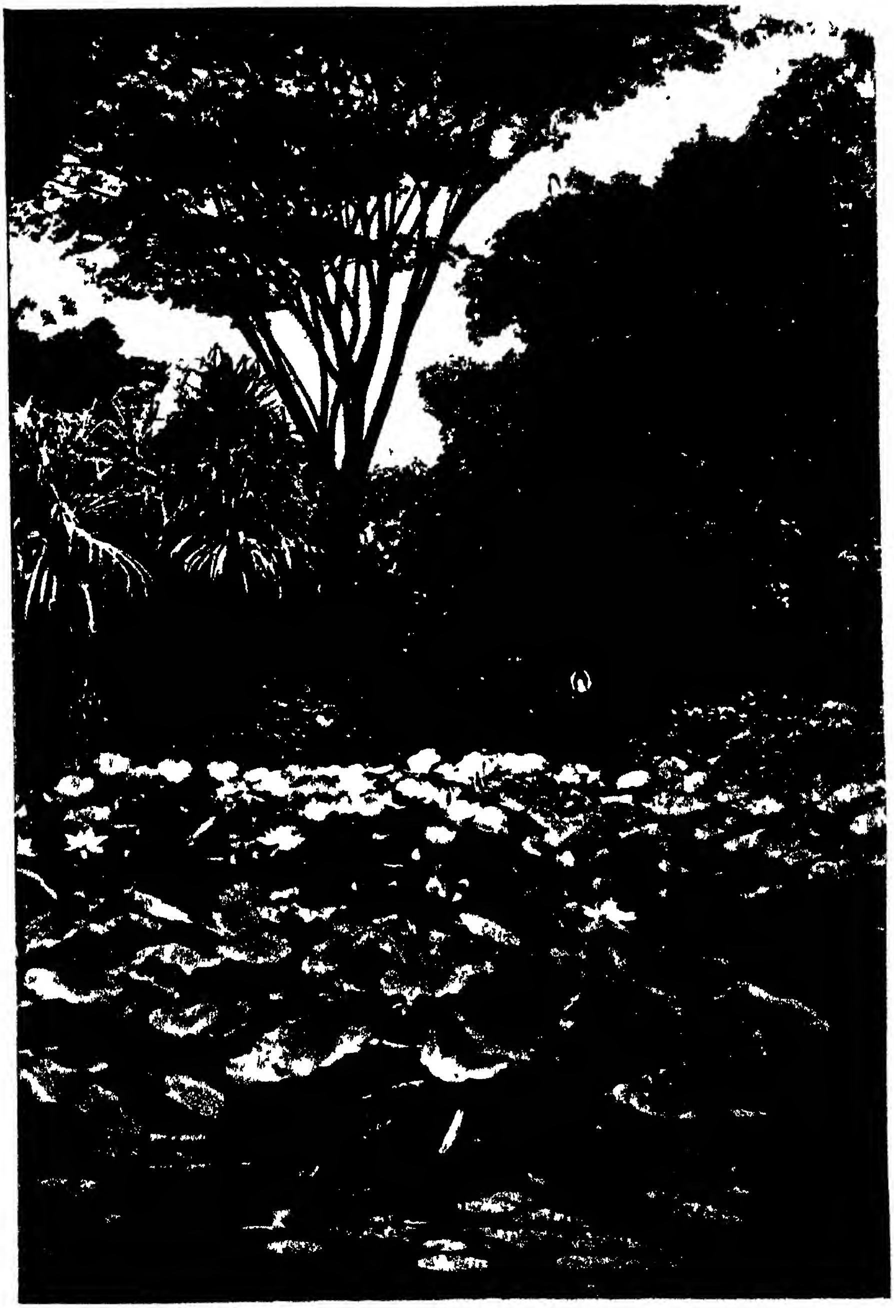
About this time we note a complaint by the Superintendent on the stealing of plants from the Garden, usually by people who should know better. In '84 a Horticultural Exhibition was held in the Garden, and in '85 there is an interesting note that the Georgetown Cricket Club had asked for assistance in planting a cherry hedge round their new ground. In 1885 also the Iron Bridges to cross the first two lakes, obtained from England in '82, were at last erected after many delays. The Sun Dial in the avenue had also arrived in '83.

In the early days of the Garden the traffic consisted chiefly of carriages, but in the nineties we find this falling off, and the number of bicycles increasing, somewhat to the annoyance of the Superintendent, who writes as follows in his report for 1896–97 :

> "Cyclists have created quite a demoralisation ; they care not for Rules or remonstrances, and any kind of control is simply out of the question. My attention has been repeatedly drawn to the fact by other visitors, entreating me to keep them entirely out of the place, and I know myself of no gardens anywhere at home that cycles are allowed into, they being confined everywhere, when off the street or high-road, to cinder-paths of their own, in enclosed grounds, for practice or exercise ; and here, also, they should be as absolutely excluded from the gardens. To all other visitors they are an anxious nuisance, more particularly the silly girls and giddy youths who appear carried away, particularly on Sunday mornings when persons would like a quiet stroll, with reckless, abandoned exhilaration and levity, unable to control their conduct. "

and again in the Report for 1897–98 :—

> " *Wheel Traffic.*—Since 1894 there has been an unfluctuating steady annual decrease in the carriage traffic in the gardens, ... due, I believe, ... to the still growing popularity of cycling with young people of both sexes. Except in collisions and spills, there is an independence in bike riding that young people who have not yet begun to realise the responsibilities of life are greatly taken with and that fills their minds



Photo] [Dr B E Dahlgren.

FIG. 7—Lotus Lilies in a Lake in the Park Lands.

with cheerfulness. . . . . Here is the record of the carriage traffic since 1893–5 :—

	Total carriages entered.	Mean daily.
1894–5	12,044	33
1895–6	10,500	29
1896–7	9,908	27
1897–8	8,200	22
1898–9	7,715	12

These figures are particularly interesting. They show that since 1894 when the cycling interest and zest had taken on well, ... the carriage traffic in the gardens has fallen 4,329 entries. . . . ."

During the ensuing years however the number of cyclists steadily increased and the carriages still continued to fall away.

We may now turn to another aspect of the Garden. In 1889 a Zoological Committee was formed, which in fact consisted of the majority of the Directors together with the Superintendent, and arrangements were made whereby a number of indigenous animals, including deer, waterhass, tapirs, etc. were kept in the Garden. A good many losses were sustained, but new additions were made to take their places, and the collection was kept up for many years. It was in 1892 that the first pair of manatees was introduced to the lakes, and by 1896 these animals had cleared the lakes of their natural vegetation to such an extent that they had to be hand fed as they are today. With regard to the lake vegetation, it is interesting to note that the Lotus Lily (*Nelumbo nucifera*), now plentiful in the Garden, and to be seen in trenches in many parts of the coastland, was first introduced in 1882, only one plant surviving from the seed planted. Two other interesting introductions to which attention may be drawn were the Double Coconuts *(Lodoicea maldivica)*, first obtained from the Seychelles and successfully germinated in 1893, and the Cajeput Tree (*Melaleuca leucadendron*), seed of which was first sent by Sir Ferdinand von Mueller from Australia with a glowing description of the value of the trees to dry up swampy land.

Mention must be made of several subordinate officers who played a part in the upbringing of the Garden. At the outset, Mr. Waby was assisted by a planter, Mr. Howell, who had charge of the task work. In 1883 the latter resigned and his place was taken by an assistant Gardener from Kew, Mr. Derry, who three years later was transferred to Malaya, making way for Mr. Ward, whose long and zealous services for the Garden only ended with his retirement in 1926, after forty years' service.

On Mr. Ward's arrival, his duties included taking charge of the meteorological records, which were kept in great detail, a set of instruments having been obtained from Kew in 1879, to which additions were made later. In this latter connection, it is interesting to note some periods of abnormal weather that affected the Garden in the first two decades of their existence. In 1884-85

there was a drought; the years 1889-1893 were five consecutive abnormally wet years, culminating with a record total of 135 inches in 1893; in the latter part of 1899 there was another drought, only 52 inches falling during the year, but it broke dramatically with the close of the century, on Old Year's night.

The first epoch in the history of the Garden closes with the death of Jenman on February 28, 1902. He had lived to see his creation successfully established, and had left a lasting memorial to his labours. Principally owing to his dislike of travel by sea, which seems to have caused him extreme illness, far beyond normal sea sickness, he had not left the Colony since 1886, even refusing the Governor's request that he attend Agricultural Conferences in Barbados in 1899 and 1901, so that his Garden had indeed become his home. He was buried near it, in St. Sidwell's Church yard. Today, visitors are reminded by the clock on the Lodge and a tablet below of the man to whose inspiration they chiefly owe the Garden which they are seeing.

A WATER RAT (*HOPLOCHILUS SCIUREUS BERBICENSIS* Morrison-Scott) DAMAGING SUGAR-CANE IN BRITISH GUIANA.

BY

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INTRODUCTION.

Rats are of common occurrence in the cane-fields of British Guiana and from time to time cause damage to an extent sufficient to necessitate special measures being taken against them. These increases, however, are usually of short duration and more or less limited in extent. On most sugar estates also a few men are more or less regularly employed as rat-catchers, who hunt these animals with dogs. In former years it is evident that rats were considered important enough to cause the mongoose to be imported from the West Indian Islands.

Just what species of rats occur in the cane-fields has not been determined previous to the present instance as far as the writer is aware, and it is probable that there are other species which attack sugar-cane besides that dealt with in the present account.

In 1936 there occurred at Blairmont Estate, Berbice, an outbreak of rats apparently unprecendented as far as actual records are concerned both as regards its proportions as well as duration and the damage inflicted, not only for that estate but also for any other in the Colony.

About the same time there occurred on two other estates in Berbice, Plns. Rose Hall and Albion, outbreaks of the same species of rat. These outbreaks have not been dealt with in the present account as no special study was made of them, but from reports and information received and a couple of isolated visits to each estate it was evident that in a general way conditions on these plantations simulated those on Blairmont estate, although in neither instance was the outbreak of the same magnitude as that of Blairmont estate.

In this connection the writer has been informed by Mr. R. B. Hunter, Manager of Pln. Versailles, that about the year 1889 a somewhat similar outbreak of rats occurred at Pln. Bath, Berbice, when sugar-cane was destroyed also. Mr. Hunter recollects especially that it was necessary on that occasion to replant a field as the result of the destruction of the tops by the rats, and also having seen the rats moving along one of the dams in numbers about dusk, apparently coming into the estate from the adjacent savannah.

THE OUTBREAK.

In November 1936, Mr. G. M. Eccles, Manager of Blairmont Estate, consulted the writer in connection with the outbreak and investigations were commenced.

The actual commencement of the outbreak Mr. Eccles informs me was in all probability about December 1935, when it was found in reaping a variety trial (field RP 24) that the plots of the seedling D 927/22 were completely destroyed by rats and had to be omitted from the results. In April 1936, the rats were first observed in large numbers in the cultivation, but it was then considered to be a seasonal infestation which would soon pass. At the reaping in October 1936 (Midlands 12–7) the seriousness of the attack was realized. It was then found that extensive damage had occurred and the yield in that section was seriously affected.

When the new ratoon crop commenced to spring it also was attacked, and at the same time adjacent fields at a later stage of growth began to be attacked.

For a while this condition continued, but later the damage appeared to cease, and for a few months little activity of the rats was observed. It was hoped, then, that the outbreak had terminated. In November of the same year however, it was evident that the rats had become active again, and damage was fairly prevalent in young fields. From that time to about the end of 1937 with only slight interruptions the rats continued to damage the crop to a serious extent.

By March 1938 the outbreak had apparently ceased and while rats were by no means absent they were not causing any serious damage.

For the period November 1936 to December 1937 the total number of rats destroyed on Blairmont Estate was 127,449 made up of 25,543 caught after fields had been reaped either as the result of flooding or in weeding and the changing of trash banks, and 101,996 caught by means of dogs at other times during the growth of the crop. At Pln. Bath between December 1936 and December 1937 the figures were 53,157 and 33,869 and 19,288 respectively.

NATURE AND EXTENT OF DAMAGE.

As previously mentioned, the damage by the rats was first observed in canes at reaping. In these fields canes were found lying on the ground as the result of lower joints being gnawed by the rats, the cane subsequently breaking off and falling.

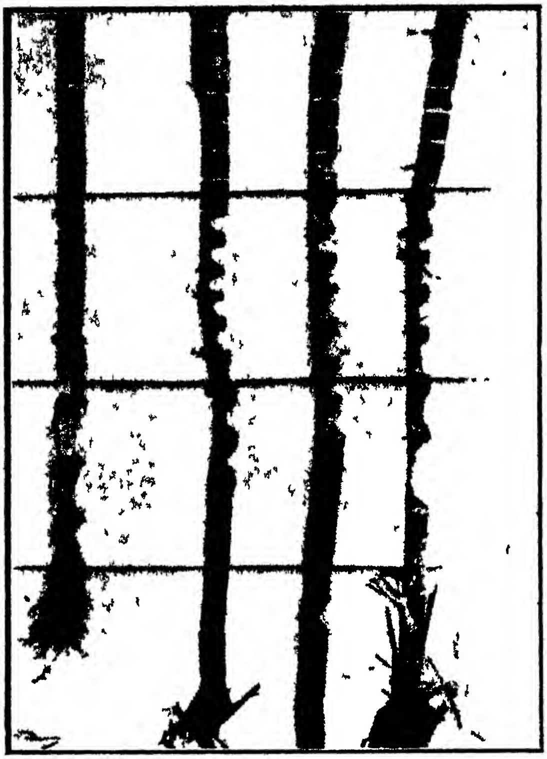
In high cane examined by the writer in November 1936 this damage was fairly prevalent. Although usually only a couple of joints were gnawed, at times as many as six or even more joints were destroyed in this way. Almost always such damage was confined to the lower parts of the stalks regardless of their height (Fig. 3). Occasionally however, a few joints higher up, and even as high as six feet from the ground were damaged.

In older canes sometimes the top of the cane was damaged. In such instances the central leaf and growing point of the stalk was eaten. Following this damage the stalk invariably commenced growth afresh from the buds lower down (Fig. 4).

Photo] [L. D. Cleare.

FIG. 1.—Nest of *Hoplochilus sciureus berbicensis* M-S, made of cane leaves.

Plate XV.



Photo] [L D Cleare

Fig 3—D image to cane st ilks by *Hoplochilus sciureus berbicensis* M S

Photo] [L. D. Cleare.

[illegible] M S

In young fields where the stalks were not more than a couple of feet in height the damage took the form of gnawing of the shoots close to the ground. Shoots thus severed were not as a rule entirely eaten but were chewed and the juices sucked, the fibrous matter being discarded to a large extent.

As to the extent of the damage some 1,500 acres on the Blairmont estate were involved, comprising principally of the sections Rampoor, Midlands, Olivier and Abary at Blairmont, Versailles and Locarno and to lesser extent Flanders, Old Bath and Diligence at Bath.

The loss caused through the rats, like all field losses, is not easy to assess, but Mr. G. M. Eccles as early as November 1936 had estimated that in a single week's working there had been a drop of "100 tons (of sugar) on the estimated yield from a block of first ratoons, entirely due to rat damage" (in litt.).

Estimating the loss due to the outbreak Mr. Eccles writes :—

"To assess the actual total damage is impossible. Apart from the direct loss "from rat-eaten canes, we do know that we definitely had to throw out of culti-"vation 225 acres, of which the spring was so badly attacked as to kill out the "stools altogether, but for this these fields would undoubtedly have been carried "on as ratoons for two or three years more according to ratoonage."

It was estimated that the loss in sugar on the Autumn crop of 1937 was in the vicinity of 1,200 tons.

As to the loss in individual fields, or groups of fields, the yields of certain fields are given below, as plant canes and as 1st ratoons.

Section.	Field.	Yield Plants.	1st Ratoons.
Ab	1	4.02	2.22
"	2	3.90	1.73
"	3	3.61	1.43
Midlands (10 acres)	12–7	5.66	2.96

THE RAT.

Specimens of the rat were submitted through the courtesy of Sir Guy Marshall, Director of the Imperial Institute of Entomology to Mr. T. C. S. Morrison-Scott, of the Department of Zoology (Mammals Section) of the British Museum (Natural History) for determination.

Mr. Morrison-Scott determined the rat as a new subspecies of *Hoplochilus sciureus* which he called *berbicensis*, and a description was published by him in the Annals and Magazine of Natural History, Ser. 10. vol. XX, pp. 535-538, November 1937, in a paper entitled "An apparently new form of Cricetine from British Guiana."

The following are the measurements and description as given (loc. cit.).

Measurements.	Head and body	Tail *	Hind foot	Ear	Condylo-basal length	Maxillary-tooth-row	Diastema	Inter-orbital width	Zygomatic width
M (type) 1937.6.24.2 (3)	178	144	39	16	36.6	7.19	11.4	4.34	21.5
M 1937.6.24.1 (1)	190	145	35	17	36.3	7.29	11.4	4.51	21.3
F 1937.6.24.4 (2)	153	132	35	17	33.8	7.17	10.6	4.37	20.4
M 1937.6.24.3 (4)	140	117	35	16	31.9	7.22	9.3	4.19	19.2
F 1937.6.24.11 (5)	146	108	35	16	Preserved whole in alcohol.				
M 1937.6.24.8 (6)	142	139	35	16					
M 1937.6.24.9 (7)	189	138	36	17					
M 1936.6.24.10 (8)	170	150	37	15					

* According to my measurements these tail-lengths were on the short side. (T.C.S.M—S.)

M = Male F = Female

"Description—*Head and body dorsally* a blackish olivaceous brown due to "a mixture of yellowish buffy-brown hairs and black hairs, black predominating. "*Flanks* clearing to cinnamon-buff. *Arms* and *legs* like flanks. Ventrally "smoke-grey, washed with yellowish cinnamon, strongly so on middle of belly. "*Hands* same as back. *Hind feet* greyish buff. *Tail* grey.

"All from same locality and caught in same month. Skin-measurements by collector in flesh."

Mr. Morrison-Scott compared the specimens with *H. guianae* Thomas (Ann. and Mag. Nat. Hist. (7) VIII, p. 149, 190) and gives the following characters :

H. sciureus berbicensis.	*H. guianae*
1. Strong admixture of black hairs dorsally	1. No black hairs dorsally, dark brown at most
2. No rusty tinge on back	2. Rusty tinge on back
3. Tail grey	3. Tail reddish-brown.

The type locality of *H. guianae* Thomas, is Kanaku Mts., British Guiana.

Finally, Mr. Morrison-Scott concludes : "It looks as though *sciureus* is not "confined to the Amazon drainage area but extends into the savannahs of " British Guiana, and that *berbicensis* is just a coastal form. "

Since the publication of Mr. Morrison-Scott's paper further specimens have been submitted to him.

Of two specimens from Pln. Versailles, West Bank Demerara, Mr. Morrison-Scott says (in litt.) :

"*Nos. 18 and 19.* These are without doubt *berbicensis*. True they are larger "than the type. [The length of head and body were 210 mm. and 200 mm. "respectively—L.D.C.] ... A fairly reliable index is to be found in the teeth "which do not alter much and No. 18 has the maxillary tooth row exactly the "same length as the type and No. 19 has this row 0. 15 mm. smaller. The "condylo-basal lengths are No. 18—38.00 mm. and No. 19—38.95 mm. "

As regards two other specimens which had been in captivity for some seven months and in which a reddish coloration had developed a couple of weeks before they were killed, Mr. Morrison-Scott says—

"*Nos. 21 and 22* are exceedingly interesting. They approximate very "closely to the type of *guianae* but their tails are not reddish-brown enough "(the root of 21's tail is about the right colour). I do not think the red is "seasonal because they were killed at the same time as 18 and 19. I wonder if it "is some condition of captivity ? The patch of red on 22's head seems abnormal. "I should be extremely interested to hear if you get any wild reddish forms— "*guianae* (= *Sciureus*) may of course overlap with *berbicensis.* "

The male of *berbicensis* is both larger and heavier than the female. Measurements have been given already. The average weight of 12 males was 167.1 grammes with a minimum of 111 gms. and a maximum of 220 gms., while the average of 10 females was 96.7 gms., with a minimum of 61 and maximum of 133 gms.

ECOLOGY.

Habitat.—At the rear of Blairmont Estate and the adjoining Pln. Bath and separated from the actual sugar-cane fields by only the empoldering dam and its canal is a vast savannah. During the wet season this savannah becomes flooded, to a depth of about eighteen inches to two feet of water.

The vegetation of this savannah is principally the sedge known as "Bizzi-bizzi" (*Cyperus articulatus* L.). Interspersed amongst this, in old water courses which are known as "creek hands", grows the broad-leaf bamboo-grass or Missouri grass as it is sometimes called, *Hymenachne amplexicaulis* (Rudge Nees). There is also in places areas of *Heliconia*, probably *H. psitticorum* L. while on fringes which abut the dams of the estates is also *Panicum laxum* Swartz.

The outstanding feature of the area as far as the outbreak of rats was concerned was the areas of bamboo grass This grass which forms rather thick clumps appears to offer conditions suitable to the rat for breeding and it is believed that this is their natural habitat.

When the investigation commenced it soon became apparent that the fields principally attacked were those situated adjacent to the savannah area. For instance, the attacks in May 1936 occurred in M. 7/12 section, and it was not until the following year that the rats had penetrated to M. 1/6.

Similarly, when the writer first visited the estate in this connection it was the Abary sections that were suffering from attacks of the rats.

Later it was found that similar conditions as to proximity of attacked fields to savannah held good at Pln. Bath also, for although the rats appeared in the sections Old Bath and Diligence on that estate which are situated at the front of the estate these sections have savannah areas in their rears.

A careful examination in the Abary fields at Blairmont when they were first visited revealed "spoor" of the rats which indicated that the animals were crossing the dam and trench separating the section from the savannah. Further, most of the damage occurred at the savannah ends of these fields.

All the field conditions, therefore, pointed to the rats having invaded the cultivation from the adjoining savannah. This was further confirmed by the statements made by East Indian labourers who had crossed these savannahs to the effect that large numbers of rats which had been drowned were seen in the savannahs and that in places where the land was either higher or in little hummocks, many rats collected.

Food and feeding habits.—In their attacks on sugar-cane the rats fed both on the young cane-shoots as well as on hard cane, and even on the "tops" of tall canes, according to the growth of the fields.

When young fields are attacked the shoots are entirely severed and portions of the softer white tissue at the base are consumed, the major part of the shoot being left uneaten on the ground with finely gnawed tissue.

In the older fields where joints have been formed these are gnawed, in most instances the joint not being entirely severed, but the stalks often break as the result of this damage so allowing further gnawing along the length. In this way the same stalk may be eaten over a period of several days and a number of consecutive joints destroyed, extending sometimes for a length of more than two feet of stalk.

While all varieties of cane were attacked there was a preference which was quite marked—thus Diamond 10 appeared to be preferred to D. 625, while other preferred varieties were Co 213, D 927/22 and D 74/30. This variety preference was so marked that in different trials the seedlings D 927/22 and D 74/30 were damaged to such an extent as to prevent suitable samples being obtained for the purpose of the experiment.

The natural food of the rat there can be little doubt is the stalks and seeds of grasses in the savannahs, and the stalks of bamboo grass are often quite as succulent as those of young sugar-cane. Instances have been observed also where the rats fed on the stalks in clumps of razor-grass (*Paspalum virgatum* L.) on dams situated between the savannahs and fields. This grass is, however, not an inhabitant of the wet savannahs which are the natural habitat of the rat.

In laboratory rearing the rats were kept for many months feeding readily on on young cane-shoots, shoots of guinea grass (*Panicum maximun* Jacq.) and also on padi.

In feeding, after the shoot has been gnawed the rat takes a portion in its hands, then sitting more or less upright proceeds to eat it using its hands to hold the food. When feeding on padi the grain was held to the mouth in the same manner while the outer shell was removed, the grain being then consumed and the husk discarded.

In the laboratory a fair amount of water was taken also.

In the field, feeding appears to be entirely nocturnal, or at least at dusk and again also in the early morning hours. This was so in the laboratory also, at least at the beginning, but after rats had been in confinement for some time they would commence to feed when supplied with fresh food about 4 p.m. although they were never observed to feed earlier than this or later than about 9 a.m., except under stress of hunger.

The amount of food consumed has been determined as regards padi as this was a convenient material to work with. For one lot of 28 rats over a total

period of 574 rat-days, the average consumption of padi per day was 11.2 grammes per rat, while for another lot of 21 rats over a total period of 113 rat-days, the average consumption of padi was 9.7 grammes per rat.

Conditions conducive to outbreaks.—As to the conditions which brought about the outbreak we can form an opinion only in so far as the conditions observed some months after the rats had become prevalent will allow.

That the rats came from the savannahs in rear of the estates there is no doubt, and likewise there can be no doubt that these savannahs are their natural habitat.

Whether severe and excessive floodings of the lands, or an over-population of the area was the primary cause of a migration of the rodents to the adjacent cane-lands, it is not possible to say. The fact remains that such migration did occur and that the savannahs, at least in November 1936, were flooded to an abnormal height. When the rains subsided later the catches of rats diminished, but again increased some months after when the next wet season occurred, and kept up as the numbers of rats show, to some extent during 1938 which was a particularly wet year.

The number of rats caught in the different sections, with total and the number per acre, show that it was the sections adjacent to the savannahs which in the beginning were most severely attacked, both at Blairmont and at Bath, the intensity diminishing and the attacks taking place later as they extended away from the savannah. Later, however, as the rats spread through the areas some of the most severely attacked fields were situated at some distance from the savannahs.

As the outbreak continued there was a gradual advancement of the rats into the longer established areas of cane, and there can be little doubt that this species of rat will become, if it is not already so, a permanent resident of the cane-fields. The rats from Pln. Versailles (Nos. 18 & 19) were taken under ordinary conditions in cane-fields, and it would seem that in this area at least the permanent association with cane-fields has already occurred.

It has been suggested that the rats were attracted to the cane and to attacking it by some condition and change in its composition, imperceptible to ourselves, brought about by waterlogged conditions of soil which are associated with newly-empoldered savannah lands, and that this was the primary cause of the outbreak and further, that as such lands became "better drained" the outbreak would automatically cease.

It is impossible with our present knowledge to prove that such is not the case, and the fact that later the outbreak ceased would seem on the face of it to substantiate this. It is true also that in newly-empoldered fields water-logging does occur at times, and that in some of the fields at Blairmont estate there were indications of such being the case, and that in such fields rats did cause considerable damage. This was not by any means general of the fields attacked, however, and certainly was definitely not so of certain fields which the writer observed in

November 1936, where young canes were being severely damaged by the rats. Against that, too, we have the fact that the outbreak although originating on the recently empoldered lands was not confined to it, indeed, as far as Blairmont and Bath were concerned, actually was as severe on some sections which had been empoldered years previously as on those only quite recently taken in. In addition of course, we have the taking of the rats at Pln. Versailles in fields of long standing.

With the older established fields, even when these are adjacent to savannahs, it appears that razor-grass (*Puspalum virgatum* L.) on dams plays an impertant part in serving as an intermediate in the spread of the rats to the cane-fields. After an area has been taken in, razor-grass soon establishes itself on the dams and at times forms a very definite and extensive association in such places, sometimes almost to the exclusion of the other grasses which were previously growing there, and while it does not ever completely take over the dams it may become the dominant species (Fig. 2).

Under such conditions the dense clumps of this grass have been observed to act not only as cover, but to serve also as nesting places for rodents, and it is believed that it may thus form a nidus for the rats.

Although it has been stated that the number of rats caught per week shows some correlation to the rainfall this should not be interpreted too literally and the prevalence of the rats considered entirely as seasonal. Consideration must be taken also of the fact that when these rats invade cane-fields they live in the interstices of the soil, made in the course of its cultivation with an agricultural fork, and with the advent of heavy rains they are driven from such places and are then more easily caught by dogs and labourers. These rats have not been observed to make burrows, but this may be due to the large amount of cover offered as the result of the method of cultivation as mentioned.

Natural Enemies.—The principal enemy of *Hoplochilus* observed in the outbreak was an *Oestrid* larva. Although not abundant it was of frequent occurrence and accounted for a fair number of rats, not perhaps directly in itself, although the injury inflicted in this way was sufficiently important, but more usually through the septic condition which followed as a result of its attack, and the secondary infection of *Cochlyomyia* that often followed in its wake.

The Oestrid larvae were usually situated behind the arms of the rat but sometimes also a little further along the body in the vicinity of the ribs. While usually only a single larva was found on a rat, sometimes as many as three would occur in one host.

The fly concerned has been determined as *Cutebra apicalis* Guer. by Dr. Van Emden through the Imperial Institute of Entomology, London.

A mite also was found frequently on these rats but this is of no economic importance.

While we have no proof that these rats are attacked by snakes, conditions observed point to this. On the empoldering dam between the savannah and the newly taken in fields, the water snakes *Liophis cobella* Linn. and *Helicops angulata* Linn. were prevalent, and in the clumps of razor-grass in which the nests of rats were frequently found, egg-masses of these snakes were of frequent occurrence.

During the rat outbreak there was a marked increase in the number of snakes also, but they diminished with the lessening of the number of rats.

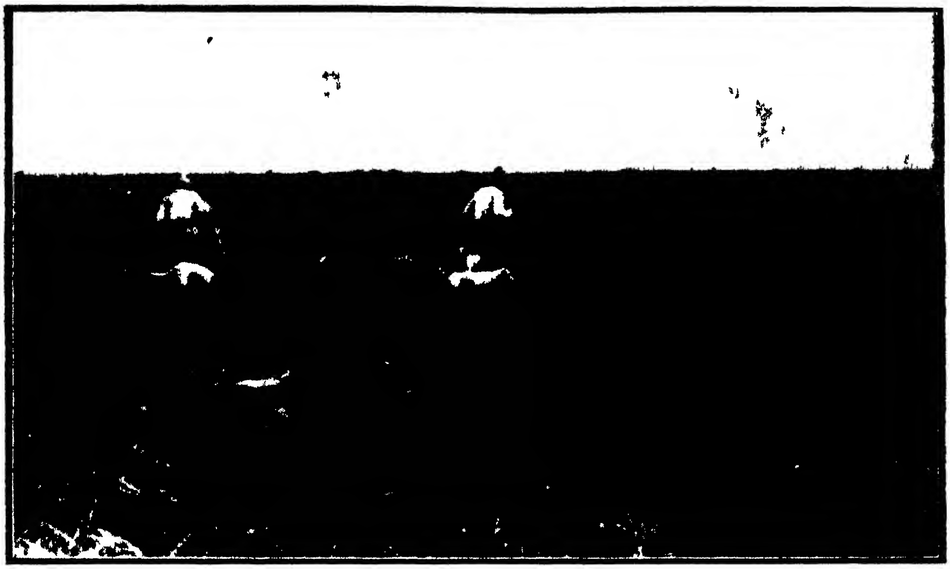
CONTROL METHODS.

Hunting.—The first efforts at control directed against the rats was hunting with dogs, and this continued throughout the campaign. This is the method adopted on sugar estates as routine against the normal rat population of the cane-fields, and it is but natural that it should be extended when conditions became more acute. As to its value as a means of control in epidemics of the nature of the one here described it is open to much discussion.

Still with a pest attacking large areas of crop and causing losses of the extent shown above, it is only reasonable to adopt such measures as appear effective on the face of them.

The actual figures of numbers of rats caught as given below do not show that the catching of large numbers of the rodents had any immediate or perceptible results, and one is left to conjecture whether there would have been any material difference in the position for the worse were such measures not undertaken.

The method of hunting consisted merely of men going through the cane-fields, and over the newly empoldered lands, with more or less trained dogs which located the rats and drove them from their hiding places. The rats were then seized by the dogs and killed, but were secured by the men before the dogs could devour them as payment was by results on the number of rats secured. The dogs used for this purpose comprised a miscellaneous collection of mongrels of particularly lean and halfstarved appearance generally grouped under the non-committal term of "hunting dog", which, nevertheless, were very efficient at the work (Figs. 5 and 6).



Photo] [L. D. Cleare.

FIG. 5.—Ratcatchers with dogs working over savannah recently empoldered and ploughed.

Photo] [L. D. Cleare.

FIG. 6.—Ratcatchers with their "hunting dogs" working in taller canes.

The number of rats caught on both Blairmont and Bath estates are given below month by month for the period November 1936 to October 1938.

	Blairmont Estate	Bath Estate	Total
1936			
November	1,153	...	1,153
December	36,647	2,008	38,655
1937			
January	23,262	7,942	31,204
February	9,044	11,746	20,790
March	7,260	7,798	15,058
April	5,741	11,574	17,315
May	10,687	4,296	14,983
June	8,247	1,790	10,037
July	4,589	913	5,502
August	5,302	1,245	6,547
September	3,654	255	3,909
October	3,485	336	3,821
November	3,698	788	4,486
December	4,680	2,466	7,146
1938			
January	8,081	866	8,947
February	1,894	1,651	3,545
March	1,202	2,582	3,784
April	2,811	3,118	5,929
May	4,139	1,421	5,560
June	930	42	972
July	1,847	223	2,070
August	4,597	687	5,284
September	1,935	144	2,079
October	66	18	84
Total ...	154,951	63,909	218,860

Poison Baits.—Within recent years there has grown a considerable literature on rat control, and papers on this subject have been published in many parts of the world. In many instances the publications have been concerned with the common house rats (*Mus*) although some deal with field rats and even species attacking sugar-cane. In most of these publications poison baits are recommended consisting principally of red squills, barium carbonate or white arsenic, and more recently thallium sulphate has come into considerable favour, in combination with substances considered to be attractants.

So when hunting with dogs did not appear to reduce materially the numbers of rats and other methods were sought, this was the line of attack which was taken. Phosphorus baits were first tried in the old West Indian form of "sulphur" matches stuck into bananas, which at the time was giving good results in Trinidad against rats in cacao-fields. Here the bait was not successful; the rats soon learnt to recognise it and either did not take the bait, or removed the matches and consumed the portion of the fruit which was not affected!

Other baits then received attention. Stock formulae recommended and used elsewhere with barium carbonate and white arsenic as their bases were tried, and later substances other than those usually recommended as attractants were used with the hope of increasing their efficiency. In this way most of the easily obtainable food substances were used including bananas (ripe and green) bread, butter, cheese, fish (salted cod), flour, lard, oats, (grain and meal), oil, cotton-seed), padi, potatoes (English and sweet), maize (grain and meal), and saccharine. Sometimes in addition aniseed oil very diluted was added as an additional attractant. Later several proprietary rat poisons received attention as well as rat virus.

At the outset it must be stated that, all of the substances mentioned previously, and all of the proprietary rat poisons, were taken by the rats to a greater or lesser extent, and when fed to laboratory rats sooner or later proved fatal, with the exception of rat virus, which probably had deteriorated in transit. In spite of this it was evident that none could be considered as being likely to prove a successful means of control for these particular rats.

The most successful of these baits proved to be padi upon which was sprinkled a proprietary rat poison of which arsenic trioxide was the active constituent. A variation of this which proved to be highly toxic was padi sprinkled with Paris green.

In the padi-arsenical trials it was revealed that the rats in feeding on the padi removed the husks and ate principally the grain within. It was evident then that any poison to be used should penetrate into the grain. Sodium arsenite in aqueous solution of 4 per cent. was therefore tried. Padi was soaked in this solution for 24 hours, then removed and allowed to dry by air.

In laboratory trials the bait was taken freely at first and proved extremely toxic, as little as 1 gram of treated padi (about 15 grains) being a fatal feed. In the field, too, where the bait was set out in "torpedoes," (*i.e.*, in a 'screw' of protecting paper) it was readily taken at first, and no doubt was equally effective. As with other baits the rats soon became "wise" to the presence of the poison and then did not take it readily. In fact in the laboratory after a time, even under the stress of no alternative food for several days, the rats refused to feed upon padi so treated, but when untreated padi was substituted they fed immediately and extensively.

Thallium sulphate baits, made to the usual formula but with padi in place of wheat at the rate of 1 to 500, put up in "torpedoes" was readily taken and the rats did not appear to detect the presence of this substance. With this bait it

was evident that the amount of thallium would have to be increased if the bait was to be effective. About this time (March 1938) the numbers of rats caught began to decrease, damaged canes seemed less in the fields, and trials with baits were discontinued.

In placing baits in the fields, especially during periods of heavy rains, it was found that "torpedoes" did not offer an efficient protection and as a result the baits deteriorated rapidly, further, the "torpedoes" were sometimes punctured by ants. The best results were obtained by setting out the baits in galvanised iron pans, or enamel-ware plates about 10 inches in diameter under roof-shaped galvanised covers of a sufficient size to afford complete protection, with the openings directed away from the prevailing wind. Although baiting in this way is not as easily done as with "torpedoes" no difficulty was experienced as the covers and pans are both light and easily portable, and the protection offered more than offsets this.

The indications from these trials of poison baits was that arsenicals, especially sodium arsenite in aqueous solution absorbed by the padi, and thallium sulphate, are both useful poisons for these rats, particularly the former on account of its inexpensiveness.

Further work would need to be carried out in connection with sodumi arsenite on the minium fatal dose and also the finding of some means of making the padi more attractive and/or disguising the presence of the poison in baits, should this be necessary when less poisonous amounts are used.

As for the situation at the present time, Mr. Eccles writes, "while the "punt-loaders still seem to catch a fair number of rats, there are practically no "signs of damage either when one rides around the cultivation or goes into the "fields. In fact, had it not been for our past experience, we should certainly "not be bothering to catch and pay for rats now, as we should have said we "'hadn't got any!'"

SUMMARY.

An account is given of an outbreak of rats which occurred at Blairmont Estate, Berbice. The species of rat concerned was found to be a new subspecies, namely *Hoplochilus sciureus berbicensis* Morrison-Scott.

Similar outbreaks occurred on other estates in Berbice about the same time, although these were not of the same magnitude.

The ecology of the outbreak is dealt with, and some account is given of the means adopted for dealing with it.

ACKNOWLEDGMENTS.

In préparing this account the writer is very conscious of the extent to which he is indebted to Mr. G. M. Eccles, Manager of the Blairmont Estate. The situation of the estate at some distance from headquarters and the pressure of other work prevented frequent visits being made, and as the result much of the routine work and the trials with poison baits was carried out under the supervision of Mr. Eccles, who, moreover, deputed Mr. L. R. Barker, formerly Deputy Manager, and Mr. J. A. Bywater to assist with the work.

A SHORT HISTORY OF THE RUPUNUNI SAVANNAHS WITH SPECIAL REFERENCE TO THE LIVESTOCK INDUSTRY.

BY

H. E. TURNER,

General Manager, Rupununi Development Co. Ltd.

Civilization came to British Guiana mainly through the medium of the Dutch. They occupied the coastal lands and such alluvial belts as lay along the various rivers within tidal influence. Sugar, Cotton, Coffee, Cacao, etc., were grown for export, and labour in the form of slaves from the West Coast of Africa was supplemented by the enslavement of Aboriginal Indians, stronger tribes often capturing and trading their weaker neighbours. As the supply of Aboriginal Indians became exhausted close at hand, expeditions were led higher up the rivers and military posts erected at strategic points. A small military post was built at the confluence of the Rupununi and Essequibo Rivers, and eventually the open country to the south, which is an offshoot of large savannahs of the Rio Branco, was discovered. No attempt was made by the Dutch to settle the savannahs of the Rupununi.

At the same time, civilization was proceeding along the Amazon through the medium of the Portuguese, who discovered the large savannahs of the Rio Branco, and used them as a dumping ground for all criminals under long sentence of imprisonment. To assist these deported prisoners, the Government sent up a small number of cattle, and it is from this nucleus that have sprung the large herds that have formed practically the sole support for an ever-increasing population in the Rio Branco District of Brazil and the smaller savannahs of the Rupununi District.

Towards the middle of the last century, British and Brazilian interests met north of the Kanaku Mountains midway between the Rupununi River and the Takutu and Ireng Rivers. British missionary met Brazilian rancher near the site of the mythical lake Amaku, on the shores of which the early adventurers had hoped to find the golden city of Manao. A clash ensued; each side was backed by its respective government, and armed forces were dispatched and faced each other near the Macusie Indian Village of Pirara, where a mission had been established. Eventually both sides withdrew and in 1906 the disputed area was finally awarded by arbitration to British Guiana.

Richard Schomburgk in his "Travels" gives a highly coloured picture of conditions at Pirara when he first visited there in 1842 in company with the British armed expedition. His account of Brazilian ranching activities should be taken with the proverbial 'grain of salt'. At the time, it is doubtful if there

was a single ranch or outstation established on what is now British territory. Stray cattle no doubt had crossed the Takutu and increased in the unoccupied country towards the Rupununi. Schomburgk speaks of rich pastures, large herds of cattle, galloping vaqueros, etc., but what he in all probability witnessed was the annual round-up of a few hundred head of stray cattle.

The Rupununi Savannahs are divided into two almost equal parts by the Kanaku Mountains which run from east to west to within three miles of the Brazilian border. At this period, the southern half, now held by the Rupununi Development Co., Ltd., was entirely in the hands of the Aboriginal Indians, without encroachment by either British or Brazilian. Slave raiding by the Brazilians seems to have been prevalent and Schomburgk describes raided and burnt Macusie Villages in the Kanaku Mountains. Inter-tribal warfare also, no doubt for the purpose of taking slaves, still went on, and many years ago the writer heard the then oldest member of the Wapisiana tribe describe how he was taken as a small boy to see the site of the last big fight and found discarded weapons still scattered about.

Latterly, however, the remaining Indians were left in peace, and by the middle of the last century were in sole possession of the savannahs with apparently little or no external influence affecting their mode of life, habits or economic outlook. A few white men toured the Rupununi from time to time in search of minerals or in scientific exploration, but the long, slow and costly transport of that day presented too many difficulties to encourage permanent settlement.

Some time between 1860 and 1870 a Dutch trader named De Roy and his wife settled on the upper Rupununi, near to what is now Dada-nawa. Hammocks and other articles of aboriginal handicraft, together with local birds and animals, which the natives are adept at rearing as pets, were purchased in exchange for salt, knives, fish hooks, etc., and disposed of on the coast. De Roy also introduced cattle into this part of the Rupununi by the purchase of some three or four head from Brazil for milking purposes.

Twenty years after De Roy's arrival, Melville, who played a great part in the development of the District, penetrated to the Upper Rupununi in search of gold. Finding the life of a trader more congenial, he settled in the District and also purchased a few head of cattle from Brazil, together with several horses.

De Roy and his wife died towards the close of the last century and Melville bought up his entire estate, including one hundred and twenty head of cattle, the increase from the original three or four. Including these, Melville's total purchases of cattle mounted to some three hundred head, and the majority of the cattle now in the Rupununi come from this one small herd of scrub stock, with little or no introduction of fresh or improved blood.

Melville was a man of extraordinary personality and energy, but he had been bred a townsman and had only very elementary knowledge of animal

husbandry. The result was that he left the care of his cattle under the supervision of a few Aboriginal Indians, who had learned a little of the local methods of handling stock in Brazil, where ranching, although conducted on very crude lines, was becoming an industry of some importance. As in every country blessed with natural feed, an ample rainfall and a complete freedom from disease, Melville's cattle throve without care and increased at a rapid rate.

There being no overland communication with the coast, all trade was with Brazil. Manaos was fast becoming an important entrepôt and port for the rubber and Brazil nut trade of the Amazon, and at the beginning of the century, Melville was exporting a few steers there, through the medium of Brazilian friends. His cattle roamed the range entirely without care, except for an annual round-up for branding, and as they increased and spread further afield, even this was omitted. No castrations were done under five years of age: hence there could be little selection of bulls. In-breeding was rampant and progressive, and the methods of handling crude in the extreme. Cattle were becoming extremely wild and difficult to round up, in fact only those in close proximity to Melville's residence at Dada-nawa were under control. These methods were continued up to, and even after, the time when Melville was able to sell out to a company, and even with the advent of fresh settlers, economic conditions have militated against any great improvement on these original methods of stock management.

The standard coin of Brazil is the milreis which in the early years of the present century had an exchange value of approximately one shilling. The steers from the Rupununi had a splendid reputation for size and quality, directly attributable to the fact that the country was still understocked. Standard steers were freely bought on the spot by Brazilian buyers for one hundred milreis (five pounds) and selected steers would run to one hundred and fifty milreis.

Export of steers from the Rupununi to Manaos was always difficult. The state laws forbade it and everything depended on the activity or cupidity of the particular officials in office. Sales becoming increasingly difficult, Melville approached the Government of British Guiana in 1917 with the project of cutting a trail to connect the savannahs with the steamer terminus on the Berbice River.

The proposal was a timely one, as the course of the Great War, which had been in progress some three years, was responsible for inflated prices and a food shortage, and the project was approved by Government. The construction of the trail was placed in Melville's hands, and towards the end of the year 1919 a few selected tame animals were driven to the coast and the trail declared open.

As a result of this, the Rupununi Development Co., Ltd. was floated, acquired Melville's cattle interests in the Rupununi, and bought out two of the four small Brazilian ranchers who had been allowed to settle on the British side of the border. In addition, a few individual settlers started ranching.

When, however, attempts were made to drive down herds of the ordinary wild range cattle, it was found that the trail was a cattle trail in name only, and lacked every facility for the driving of stock. Actually, the trail at this period

FIG. 1—The Effect on Pasture of overstocking. The Grazing behind the Fence is controlled

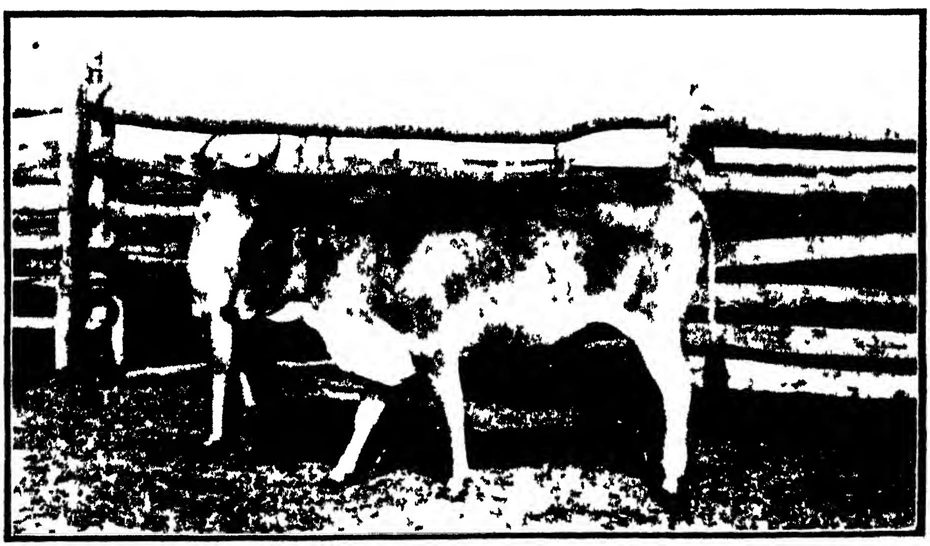


FIG. 2—Crossbred Zebu Hereford Heifer (½ Zebu, ¼ Hereford, ¼ Rupununi)

Plate XVIII.

Fig. 3.—A Herd crossing the Rupununi River

Fig. 4.—Driving a Mixed Herd

was nothing more than a clearing cut through the forest with all trees over four inches in diameter left standing. Clearings for grazing, and paddocks or corrals for holding the cattle at night, were non-existent. High creek banks were ungraded, and the swamps, lacking corduroys, were well-nigh impassable. Rest houses there were none, and the trail proved a 'via dolorosa' for both man and beast, so that for the first two years the losses incurred in driving cattle through it were terrible.

The Rupununi Development Co., Ltd. now owns the larger part of the stock in the Rupununi and therefore a short account of its development will not be out of place. Towards the end of the Great War and in the early post-war years a wave of speculation swept the Colony. Sugar—the staple industry—was booming, and it was only natural that the opening up of what was considered to be a rich and undeveloped stock-raising country should be expected to result in added prosperity.

Floated towards the end of 1919, the properties acquired by the Rupununi Development Co., Ltd. were purchased at a figure far above their actual value. The main property, Dada-nawa, was a ranch in name only. Equipment, fences, corrals, etc., were non-existent. There were some 15,000 head of scrub cattle of which a few only could be termed domesticated, the remainder being little better than wild animals. Despite the fact that there was talk of raising cattle by the hundreds of thousands, overstocking was already in evidence in some places (though large areas of course were still entirely unstocked) and numbers of cattle were of poor conformation, stunted and in wretched condition. Little notice had as yet been taken of the warning of Professor Harrison, Director of Science and Agriculture, that owing to the lack of essential minerals and the sterility of much of the soil, the number of cattle that the savannahs could support was limited. He estimated one animal to twenty acres, although an overall average of one to thirty acres would now be nearer the mark.

Amply provided with working capital, the policy should have been to devote the first year at least to organizing and equipping the ranches, and perfecting a system of driving the herds through the newly opened and as yet untested trail. Unfortunately, owing to lack of knowledge of conditions up-country an exactly opposite policy was adopted. Herds of cattle were, without preparation or organization, rushed away from the ranches, the majority to be lost in the roughly cut cattle trail. But the post-war slump had already set in, livestock values were dropping and all other activities were neglected in an attempt to bring large numbers of cattle to the coast.

By the latter part of 1921 the Company's position already seemed hopeless. Almost the entire working capital had disappeared and but few steers had arrived on the coast for sale. Nothing had as yet been done towards the development of the ranches. Actually, they were in the same condition as when purchased, except that the best of the steers had already been removed, the majority to be lost in transit to the coast. A reorganization was obviously essential and this was carried out, the Company narrowly avoiding liquidation and being left financially crippled.

The second phase consisted of a long uphill struggle without reserves and against a constant drop in livestock prices which continued until 1936. During this period, everything possible was done to develop the ranches, but economic conditions limited the progress made. Pure bred bulls were imported, scores of miles of fencing constructed, numerous out-stations built and the cattle brought under control. Improvements could only be carried out when livestock prices allowed of a working profit being made, and during this second phase all such profits were put back into the properties. Progress has, however, been slow and the quality of the stock still leaves much to be desired.

So much for the Company. The history of the small settler has been even more unfortunate, and those not possessing some alternative source of revenue, such as balata bleeding, were in many cases reduced to a state of dire poverty. At one period, ranchers were driving their cattle to the coast to sell for $10 per head and of this amount $1.50 was paid for trail toll and over $3 in freight from the terminus of the trail to Georgetown. It was felt by them that although for years the cry had been to settle the interior, and the Rupununi District was the only part of the far interior where settlers, the majority Europeans, lived, worked and brought up their families, yet their pioneering problems were either completely ignored or treated with scant sympathy. In an area of several thousand square miles with a resident population of at least four thousand there is still no medical service and only one small mission school for Aboriginal Indian children.

Under these conditions, the small rancher has done little or nothing towards improving his stock. For some considerable period in fact he entirely discontinued driving his cattle to the coast, as the price obtained barely covered the expenses incurred between ranch and market.

The main reason for his economic troubles, apart from the difficulties of communication, is the poor quality of his stock. He is caught in a vicious circle, since his poor quality cattle bring low prices, and these allow of no surplus to be expended on the improvement of stock. He has been blamed for being unprogressive, but the fault is not entirely his. It is possible that if Government, when opening the cattle trail, had started a small stock farm in the District for the purpose of breeding improved beef type bulls for sale to the settlers, there would now be a different tale to tell. Settlers who were in no position financially to import their own pure bred bulls into the District would undoubtedly have purchased cross breds on the spot had they been available.

In the early days, stock in the Rupununi was entirely free from disease, but the same cannot be said to-day. A veterinary surgeon permanently stationed in the District is needed, or failing this, a lengthy visit by a properly equipped veterinary expedition definitely to establish the nature of the stock diseases now prevalent in the District, and advise settlers on the methods of combating them.

The idea that the Rupununi District is a rich stock-raising area capable of holding hundreds of thousands of head of cattle is a fallacy. Although certain areas are still capable of holding more cattle, large areas are already heavily overstocked, and this mainly accounts for the extremely poor quality of much of the stock.

The soil of the Rupununi savannahs consists of two main types. In the first place, there is the sandy soil of the high lands and low hills and ridges, which Professor Harrison described as being 'barren to sterile', and it has been proved that the coarse tuft grass growing on these areas is markedly deficient in minerals and of practically no feed value. Cattle will only graze this grass when it is springing up soft and green after burning, or when forced to by lack of pasturage on the low ground.

Secondly, there is the clay soil of the flats and low ground which mostly lies along the creeks and rivers. These flats flood over for short periods during the wet season and receive deposits of alluvium. Much of this soil is of well marked fertility, and although deficient in essential minerals, produces herbage of definite nutritive value on which cattle thrive. It may here be noted that the feeding of artificials to the stock to make up for the marked mineral deficiency in all types of grazing is, under present conditions, almost out of the question owing to the extremely high cost of transportation from the coast.

For all practical purposes, therefore, the grazing on the high lands can be regarded as of little or no value. This means that the number of cattle that can be carried on any given area is limited by the extent of the low lands. Certain areas are almost totally deficient of good pasturage, and it is the absence of cattle in these areas that gives rise to the reports that the savannahs are still very much understocked.

Taken as a whole, the grazing which is of value does not comprise a fifth of the entire area. When a range is understocked, the cattle graze in the most favourable swamps only, and as a rule are in splendid condition. Once the economic stocking-up point in numbers is passed, however, these good grazing areas become denuded of grass, and eventually semi-starvation forces the cattle to graze on the coarse grass of the high lands. When this occurs, the stock becomes miserable in the extreme both as regards size, conformation and condition.

To, sum up, the Rupununi savannahs in the writer's opinion can produce some five thousand head of marketable steers per annum together with a proportionate number of spayed females. Owing to the sparseness of the grazing, the open range system is the only economic method of running the main herds, but fencing is essential for the purpose of breeding up small herds of improved stock to provide bulls for the open range. Adequate fencing, better bulls and proper range control can eventually produce good quality beef cattle, both for the local market and the West Indian export trade. Breeding

experiments by the Rupununi Development Co. Ltd. favour a Hereford-Zebu cross, and grazing tests show that not more than an average of one animal to thirty acres should be carried.

Primitive methods of stock management, enforced by economic conditions, and inbreeding have undoubtedly had an adverse effect ; but overstocking is the main factor in the deterioration of much of the stock in the Rupununi District. Overstocking on the open range can most effectively be overcome by spaying heifers, and this practice allows ot the selection of the females to be retained for breeding and of turning scrub heifers into marketable beef animals. The spaying of all undesirable heifers from overstocked country, and a percentage of the poorer animals from stocked up areas, is now a matter of routine on the Rupununi Development Co's. main station, but has still to be introduced by other owners.

DAMAGE CAUSED TO RUM PUNCHEONS BY BORING BEETLES.

BY

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I. Introduction.

The investigation dealt with here was undertaken between November 1937 and January 1938 and was the direct outcome of a complaint received of damage by boring beetles to the puncheons of a shipment of rum made to London from British Guiana in August 1937.

The shipment of rum concerned comprised 141 puncheons from two sugar factories and was reported as having, on arrival at London, 76 puncheons (54 per cent.) bored by beetles so that repairs were necessary to the puncheons in London. The report showed that in the 76 puncheons there were 173 bored staves.

The puncheons were made at Georgetown, the staves being imported from the United States of America.

From the first it was evident that there might be difficulty in forming a definite opinion as to where the damage to the puncheons in question had taken place, for it was possible that the attack might have occurred at many points between the receipt of the staves at Georgetown and the final arrival of the packages in London. This was further added to by the absence, at the beginning, of the damaged puncheons so that a more extensive enquiry had to be undertaken than perhaps would have been necessary otherwise.

II. Damage to New Staves.

An examination was made first of new staves, and stacks of staves at the cooperage wharf at Georgetown of varying dates of arrival were examined, while on 9th November a new shipment of headers was received and these latter were examined both at the time of their arrival and also a few days afterwards.

At the outset it must be stated that both such staves and headers showed damage which was evidently the result of beetle attacks, and judging from the borings in the wood had been caused by probably at least three different species of insects. In spite of this no boring beetles were found and it was evident that the damage had occurred some time previously.

This damage was not excessive and amounted to 6.7 per cent. over the three lots examined. The details of these examinations are as under :

Lot No.	Date of examination	Material	Ex Ship.	No. examined	No. bored	Per cent. bored
I	16.xi.37.	Headers	ss.—— 10.xi.37. (Brown spot)	571	41	6.2
II	17.xi.37.	Staves	ss.—— 13.x.37. (Grey spot)	370	36	9.7
III	17.xi 37.	Headers	ss.—— 23.vii.37. (Green spot)	416	16	3.8

The damage in both staves and headers was usually quite noticeable and in many instances it was obvious that should such material be used in packages it would cause leakage.

In staves with the smallest sized holes it was not apparent at first whether these were capable of causing leakage. Careful examinations were made, therefore, of a number of these borings by splitting and sectioning the staves, and in several instances it was found that even these holes of small diameter had gone through the staves.

In the headers the damage, usually a larger-sized hole, invariably took the form of an oblique boring at the edge of the particular piece of wood, and here again it was obvious that should such material be built into a package there was likelihood of leakage resulting therefrom.

III. Damage to 'Grogged' Puncheons.*

It has long been known amongst coopers in the Colony that puncheons which have been "skipped" and "grogged" when stored for a time, either before or after being repaired, develop "worms" which will in time cause leaks, and these worms may occur to such an extent as to cause the package to be discarded.

The staves of these packages in the course of their storage with rum prior to skipping become soaked with the liquor, and in spite of the grogging still retain some of the alcohol in the wood. When water is placed in these puncheons subsequently some of this alcohol is drawn from the wood, a fermenation is set up and beetles are attracted.

Samples of water from grogged puncheons both at the Colonial Bond and at the cooperage were obtained and the alcoholic content determined. The figures in this connexion are given in Table I.

*When rum puncheons have been in bond for some time defects in the puncheons such as broken staves necessitate a certain number of the packages being changed, the rum being transferred to other puncheons ; this process is known as "skipping".

"Skipping" having taken place the old package is then "grogged", *i.e.*, water put in and retained for a period and then thrown away.

TABLE I.—ALCOHOLIC CONTENT OF WATER FROM GROGGED PUNCHEONS

Sample No.	Date case filled	Date grogged	Date examined	Examination of Liquor			
				Temperature	Indication	% U.P.	% Alcohol by Volume
I			7.xii.37.	85.0	93.2	85.5	8.1
II			7.xii.37.	86.0	92.8	84.7	8.7
III			8.xii.37.	86.0	92.2	83.1	9.6
IV			8.xii.37.	86.0	92.0	82.6	9.8
V			8.xii.37.	86.0	91.8	82.6	9.8
VI			8.xii.37.	86.0	91.6	81.6	10.4
VII			8.xii.37.	86.0	92.0	82.6	9.8
VIII			8.xii.37.	86.0	92.0	82.6	9.8
IX	1935	17.xii.37.	20.xii.37.	80.0	97.6	95.6	2.4
X	1937	approx. 20.xi.37.	20.xii.37.	78.0	96.6	93.0	3.9
XI	1937	? 1 month ago	20.xii.37.	80.0	97.4	95.2	2.6
XII	1934	2-3 weeks ago	29.xii.37.	80.0	98.2	97.1	1.6

A few such "grogged" puncheons were examined, and by carefully sectioning staves from one of these infested puncheons some of the beetles which were attacking them were secured. These beetles proved on examination to be a species of *Xyleborus*, which genus is well known as wood borers.

The attack in such puncheons often occurs in the headers or around the groove where the header fits into the staves, but also in the staves themselves about the central area where the puncheon comes in contact with the ground when stored on its side. In most instances seen where the attack occurred about the centre of the stave it could be associated with some injury to the stave, sometimes only a small indentation, which had allowed ingress of the beetle.

When the damage occurs in the headers, or in their immediate vicinity, the groove, a leak is readily formed, as may also occur if the damage is between two staves. When a stave is penetrated directly, however, the entrance of the beetle in itself may not result in leakage, for in such instances, the beetle, or its larva, does not penetrate beyond a point in the wood where it becomes more or less soaked with the contained spirit. Under such conditions, where leakage occurs it is invariably associated with cracks in the wood often brought about by extreme heating, and the resulting burning and cracking, in the process of making the puncheon.

IV. Examination of Staves from Damaged Puncheons.

A number of staves removed from puncheons which showed beetle borings were examined comprising (a) staves from puncheons in the Colony and (b) staves from puncheons returned from London around which this enquiry started. These will be dealt with separately.

(a) *Staves from puncheons in the Colony.* A number of puncheons which had been shipped to a plantation from the cooperage in the latter part of November, were reported on arrival at the factory to be bored, and later when the damaged staves from these puncheons were removed and returned to Georgetown they were examined.

These puncheons were made at Georgetown in October and shipped from Georgetown between the 27th and 29th October, and on 6th or 7th November, while at the sugar factory, they were observed to be bored. The shipment comprised 100 puncheons, and 30 of these showed "worm holes" in some of their staves. Twenty-eight of these damaged staves, and three header-pieces were received at Georgetown on 15th December, sent to this laboratory on the following day, and examined on 17th December. Of these staves eighteen were found to be damaged sufficiently to cause leakage, it is believed, and, in ten staves, it was not possible to be certain whether the damage was of such a nature as to cause leakage.

The detailed results of this examination are given in Table II.

TABLE II.—EXAMINATION OF DAMAGED STAVES FROM PUNCHEONS EX-SHIPMENT OF 27TH/29TH OCTOBER, 1937.

Group.	Number of Holes.				
	Outer side of staves *only*	Inner side *only*	Extending through staves		Total
			Plugged	Not plugged	
A—18 staves damage in which would cause leakage	9	38	58	19	124 (1)
B—10 staves damage *may* cause leakage	16 (2)	3	—	—	19

All of this damage had evidently occurred some time previously, and, in some instances at least, before the packages were constructed and was the same as that occurring in new imported staves.

(b) *Staves from puncheons returned from London.* Late in December six puncheons were received at Georgetown from London which puncheons were stated to be part of the consignment complained about and to be damaged by beetle borers.

On arrival these puncheons were seen and beetle borings were quite apparent in all, even on very cursory examination.

At a later date, careful examinations of these packages were carried out, and the results of the examinations are given below.

The marks on these puncheons showed that they were the product of two cooperages in Georgetown, and were as follows:

(1) In Group A of a total of 124 holes, 22 were situated under the bands of the puncheons, of which 19 had been plugged and 3 not plugged.

(2) In Group B of the 16 holes showing on the outer side of the staves, 6 were only surface holes and had been plugged.

TABLE III.—MARKS ON PUNCHEONS EXAMINED.

Puncheon	Estate Marks (Stencilled on top)	Colonial Bond Marks (scribed)	Colonial Bond Details.
A	1936 PA 616 Tare 176 lb. 100 gals.	5161 36	13 Oct., 1936 Pln.— Mark—A. 92 puncheons coloured rum
B	1935 G 97	262 33	13 Feby., 1935 Pln.— Mark—MAS 60 puncheons coloured rum
C	1936 G1 T. 1.2.25. (other marks 1935 46 Cooperage)	R1 1590/95	In Bond 9 April 1936 6 Hogshead MAS (Pln.—) Racked into 3 puncheons 30 July 1937 G R1—3/1590/95 shipped ss.——4 Aug. 1937
D	1935 G 492	1320 35	5 April 1935 Pln.— Mark—KF (?) M. 28 puncheons coloured Rum
E	1937 CCC 297 T. 1.3.7	4275 37	4 Aug. 1937 Pln.— Mark CCC. 59 puncheons coloured rum
F	P H R 628 1936 Tare 184 lb. 100 gals.	5173 36	Date as in Puncheon A above

Both the Colonial Bond and the estate marks on the packages showed that only one of the six packages contained 1937 rum. The other five contained either 1935 or 1936 rum. Although the package "C" contained 1936 rum, the liquor was placed in it only in July 1937, but th package itself was evidently constructed in 1935 and had apparently been used at some time previously to the occasion of the last shipment. All the packages, with the possible exception of "C," had been in the Colonial Bond for some time prior to shipment, one since February 1935 (B), another since April 1935 (D) and a third since October 1936 (A).

The borings in these puncheons were located almost entirely towards the ends of the puncheons, that is, where the puncheons tapered and not about the middle and greatest girth, and staves in all positions in the puncheons were found to be bored.

Further examination of the borings themselves showed that the majority did not extend for any depth into the staves and in fact many were only surface borings. Those which penetrated the staves did so always across the grain of the wood and often in a diagonal direction coming out on the sides of the staves where they were in contact with the adjacent staves, and invariably did not go beyond a point in the wood where it became sodden with the contained alcohol. Some of the boring commenced at a point where two staves abutted and where there was a slight indentation which allowed ingress of the beetle.

In two instances at least when a puncheon was broken down it was observed that between two staves there still existed the "flag" (made of the fibre from plantain pseudostem) which had been placed there in the coopering of the package in order to make a tight joint. And what was especially important was that these "flags" had been penetrated by beetle borings.

No such borings of the "flags" could have existed before they were put in place in the packages and the fact that the borings of the flags and of the staves coincided and were identical in every respect left no doubt of their having occurred at a later date.

In another instance there was found a hoop to which wood fibres were adhering, and the area of the staves immediately adjacent to this was severely bored.

A very careful and detailed examination was made then of a number of individual staves, and dissection of boring carried out. Staves from each of the five puncheons were thus examined. In this way, in staves from each package beetles were obtained which had died in their borings and which on examination proved to belong to the genus *Xyleborus*.

As regards these puncheons from London, then, the facts pointed to the damage having occurred after the filling of the packages, and also after their removal from the Colonial Bond, and indeed, suggested that the damage had occurred in transit.

V. Dunnage Wood.

Suspicion fell upon the dunnage wood used in storing the puncheons on shipboard. Accordingly, a stack of this dunnage in the vicinity of the cooperage and shipping wharf was examined.

This dunnage is comprised of a miscellaneous collection of local wood, among which examples of Congo Pump, (*Cecropia spp.*) Hog Plum (*Spondias Monbin* L.) and Shiroua, (*Nectandra spp.*) were seen.

Ample evidence was soon obtained that some of this wood was severely attacked by beetles, and further examination disclosed that beetles of the genus *Xyleborus* constituted the majority of these insects.

In this material the *Xyleborus* attack was at the time of my examination still active and there was little difficulty of obtaining live beetles although it was evident that the stack had been in position for some weeks.

VI. Conclusions and Recommendations.

From what has been stated above under the different sections it will be seen that beetle damage as found in the present investigation falls into two distinct categories, namely (i) that occurring in new staves, and (ii) that occurring in puncheons in one form or another.

(i) *Damage occurring in new staves.* Little need be said as regards this. It has been stated already that it is the result of beetle attacks before the arrival of the staves in the Colony, and probably occurred at the point of logging operations. Sufficient it is not active when the staves are received in British Guiana, and as the percentage of staves damaged is not high the allowance made by the suppliers (1,200 staves are given per mille rate) is ample to allow for rejections arising from this cause. Incorporation of staves damaged in this manner into puncheons, as previously pointed out, would in many instances cause leakage.

(ii) *Damage occurring in puncheons.* In grogged puncheons which were in storage and in the puncheons returned from London, as has been stated previously, *Xyleborus* beetles were found to be the cause of the damage.

Beetles of the genus *Xyleborus* are well known as timber borers in different parts of the world. On account of their habit of feeding on certain fungi which grow in the tunnels which they make in the wood an essential for their existence is that the wood which they bore must be at least moist, and conversely one of the characteristics of these beetles is that they do not attack dried and seasoned wood.

Accordingly, normally it would not be expected that these beetles would attack rum puncheons. If, however, the exterior of a puncheon, either empty, artly filled with weak alcoholic solution or even with rum itself, is wet for

some time, or comes in direct with some substance itself more or less wet over a period of time long enough to allow the wood of the puncheon to take up moisture such a puncheon might be attacked by *Xyleborus* beetles.

The damage caused to grogged puncheons was not investigated in the present instance beyond the point of establishing such damage and ascertaining the insect concerned.

As regards the puncheons returned from London, the fact that the attack was not seen when it first occurred and in an active state, and that several weeks had elapsed before the packages were examined, any conclusions arrived at in this connection must necessarily be of a circumstantial nature.

With this reservation then, it may be said that as the result of investigations and the conditions observed, and the examinations made of the puncheons, there is reason to believe that the damage to these puncheons occurred after the packages were removed from the Colonial Bond, and in all probability while they were in transit to London. Further, that such damage was caused by *Xyleborus* beetles (*Xyleborus badius* Eich. Det. K. E. Schedl, through Imperial Institute of Entomology, London) some of which were found in the borings in the puncheons; that such beetles were breeding in all probability in the dunnage wood used with this shipment of rum and that the puncheons were infested and damaged by such beetles.

The measures to be adopted with regard to damage to puncheons in transit and arising from the dunnage wood is, of course, a change in the material used as dunnage. In this connection, it was suggested that perhaps wallaba (*Eperua* spp.) "ton-wood" might be used instead of the present miscellaneous "cord-wood." This is not recommended as the sapwood of wallaba also has been observed to be attacked by several species of *Xyleborus* beetles.

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PART I.

GENERAL AND MISCELLANEOUS AGRICULTURAL LEGISLATION.

AGRICULTURE—GENERAL.

The Board of Agriculture Ordinance, No. 26 of 1934.

Under this Ordinance there is established an advisory Board of Agriculture consisting of the Director of Agriculture who shall be Chairman, the Deputy Director of Agriculture who shall be Vice-Chairman and not more than seven other persons who shall be appointed by the Governor. Every appointed member shall hold office for three years, but shall be eligible for re-appointment. The Governor may appoint some person to be a member in place of an appointed member who is absent on leave (which may be granted by the Governor) or owing to death or other cause. The Board shall meet at least once every three months, or at any time at the request, in writing, of three members stating the purpose for which the meeting is required.

Under this Ordinance the Board of Agriculture Ordinance, No. 27 of 1920, (Cap. 150) is repealed.

The Crops and Livestock Registration Ordinance, No. 22 of 1917, (Cap. 159).

By this Ordinance the occupier of any land or the owner of any livestock is required to give, before the last day of January of each year, returns on the approved forms showing the acreage of land under cultivation at the date of the return, and the crops and produce thereof reaped during the year ending on that date, also the number of animals kept at the date of the return, and their increase during the year ending on that date.

The Crown Lands Regulations 1919, made under section 17 of the Crown Lands Ordinance, No. 32 of 1903, (Cap. 171) contain a number of regulations concerning Agriculture.

Part I deals with Applications for Grants or Leases, Licences or Permissions of Crown Lands and the Renewal, Revision, Transfer, etc., of the same. Part II is concerned with surveys, where such are required, and Part IV deals with Grants to small cultivators.

Part V covers leases both for agricultural purposes and for grazing purposes, and Part VI deals with Permission for Grazing Areas in the interior.

Part VIII embraces Leases and Licences to cut wood and Part IX Licences to collect Balata and Gums, etc. Regulations 70 and 71 *et seq* in this latter part prescribe for the collection of Orchids and other Forest Products such as Haiari (*Lonchocarpus spp.*), Tonka Beans, etc., for which permission has to be obtained from the Commissioner of Lands and Mines.

Part X, Regulations 80 *et seq* deal with the removal of sand or shell from Crown Lands.

LANDS AND MINES AND FORESTRY DEPARTMENT ORDINANCES RELATED TO AGRICULTURE.

The following Ordinances may under certain circumstances concern the Department of Agriculture.

The Lands and Mines Department Ordinance, No. 31 of 1903, (Cap. 166) makes provisions as to Crown and Colony Lands. *The Land Surveyors Ordinance, No. 20 of 1891*, (Cap. 167) covers the making of surveys, and the *District Lands Partition and Re-allotment Ordinance, No 16. of 1926*, (Cap. 169) concerns the partitioning and re-allotment of land.

The Crown Lands Ordinance, No. 32 of 1903, (Cap. 171) deals with the leasing, etc., of Crown Lands, and contains (section 17 (5)) Regulations as to the Rupununi Cattle Trail and the payment of Tolls thereon. Further regulations made under this Ordinance have been dealt with above in the section concerning the Crown Lands Regulations, 1919.

The Crown Lands Resumption Ordinance, No. 30 of 1905, (Cap. 172) deals with land which has been abandoned for more than 8 years, and the owners of which are called upon to prefer their claims, and *The Polder Ordinance, No. 25 of 1910*, (Cap. 174) deals with the creation of Polders.

The Forestry Ordinance, No. 29 of 1927, (Cap. 176) covers the demarcation and regulation of Forest Reserve areas, and the unlawful possession of Forest Produce.

SUGAR.

The Sugar Experiment Stations Ordinance, No. 33 of 1937.

This Ordinance makes provision for a Committee, consisting of six persons immediately connected with the Sugar Industry, together with the Director of Agriculture as Chairman, to maintain and manage such Sugar Experiment Stations as may be deemed necessary, and to appoint such executive officers as may be required. Expenses shall be paid out of a Sugar Experiment Stations Fund and a rate calculated on the acreage of land under sugar cane cultivation is levied on the Sugar Plantations, 60 per cent. of the amount due being payable on or

before January 31 and 40 per cent. on or before June 30. Where investigation of an extraordinary nature becomes necessary, an additional rate may be levied. The Committee may make regulations, subject to the approval of the Governor-in-Council, to carry out the provisions of the Ordinance.

Under this Ordinance the previous Sugar Experiment Stations Ordinances No. 41 of 1932 and Nos. 14 and 31 of 1934 are repealed.

Sugar (Regulation of Prices) Ordinance, No. 15 of 1930.

By this Ordinance the Governor is empowered to fix the maximum price for which the various grades of sugar manufactured in the Colony may be retailed.

Sugar (Temporary) Excise Duty Ordinance, No. 2 of 1932 amended by the Sugar (Temporary) Excise Duty (Amendment) Ordinance, No. 5 of 1937.

These Ordinances impose an excise duty at the rate of 90 cents on every 100 pounds weight of all sugar manufactured in the Colony and sold for home consumption. The first Ordinance provides for the keeping of the necessary books by Sugar manufacturers and producers, and limits the price of sugar liable to duty. It also sets out the method of payment of duty.

Sugar (Temporary) Excise Duty Regulations, 1932.

These Regulations, made under the provisions of Section 2 (1) of the Excise (Regulations) Ordinance, No. 21 of 1905, (Cap. 40) stipulate more fully the form of books to be kept in accordance with the above Ordinance, (No. 2 of 1932). They also specify that all Sugar manufactured at a factory must be packed in bags containing either 250 pounds, 125 pounds or 112 pounds of sugar nett weight.

The Sugar Quota Ordinance, No. 19 of 1937.

This Ordinance restricts and regulates the export of Sugar from the Colony by the allocation to local manufacturers of quotas for exportation. Sugar may only be exported under licence and export certificate.

Molasses (Disposal) Ordinance, No. 23 of 1931.

This Ordinance makes it compulsory for any persons disposing of molasses, except for export from the Colony, to keep a Molasses disposal book in which must be recorded details of sale. A statement of these sales must be submitted to the Commissary monthly. No person may sell or receive more than two gallons without a certificate.

Molasses (Disposal) Ordinance, No. 41 of 1933.

This Ordinance makes it obligatory for any person receiving Molasses, except for export purposes, to state in writing the purpose for which he desires to obtain the molasses. No person may sell or receive more than two gallons of molasses except there be also provided a certificate of the sale.

RICE.

The Rice (Export Grading) Ordinance, No. 18 of 1930 amended by the Rice (Export Grading) Ordinance, No. 40 of 1932.

These Ordinances prohibit the export of Rice without inspection and grading and stipulate that shipments of Rice for export shall be blended so as to ensure that the contents of each individual container of a consignment are uniform. Inspectors to enforce these laws are to be appointed by the Director of Agriculture with the approval of the Governor-in-Council. Provision is made for the appeal to the Director of Agriculture by any aggrieved person against any decision of an Inspector.

Rice (Export Blending and Grading) Regulations, 1934 amended by Rice (Export Blending and Grading) Regulations (No. 3), 1934.

The grades of Rice are described in a schedule attached to the Regulations and in the amendment. No Rice other than Broken and Super Broken may be submitted for grading unless it has been previously blended. No person shall blend Rice unless he has first obtained a licence for the purpose from the Director of Agriculture and such licensed blenders shall be registered. A licence ceases to have effect at the end of every financial year, but may be renewed for the ensuing financial year. The Director may, if he considers fit, remove from the register the name of any blender. The blender's fee is limited to two cents per 100 pound bag and four cents per bag over 100 pounds. A set of guide samples according to grades will be supplied by the Department of Agriculture to registered exporters of Rice. Rice for export shall be delivered at specified wharves and in new bags. Application for grading must be made to the Inspector not less than 24 hours prior to shipment. Each application for grading must be accompanied by the certificate of a registered blender certifying that the Rice has been blended and must be signed by the Secretary of the Rice marketing Board before they are delivered to the Inspector. Consignments of Rice must be pointed out to the Inspector by the owner or his agent on the wharf and the Inspector shall examine by samples a minimum of 25 per cent. of the bags. The consignor shall pay a grading fee at the rate of one cent per bag of 100 pounds or less and at 1½ cents per bag of more than 100 pounds. After samples have been taken from a consignment the exporter shall present his Customs specification form, on which is indicated the name of the wharf, to the Inspector for certification. At the time of exportation this form shall then be presented to the wharfinger who will attach a further certificate stating that the Rice specified is the same as that examined by the Inspector. The specification form and Wharfinger's certificate shall be delivered to the Customs Officer at the time of shipment. If Rice has been graded and is removed from the place of delivery without being shipped it must be regraded before export. A grading certificate remains valid for 14 days; it may be renewed under the authority of the Director of Agriculture. The exportation of Rice infected with insect pests or fungi, or with objectionable odour, is forbidden, and provision is made for the

removal of such Rice. All Rice exported must conform to the standards of the grades described in the Schedule attached to the Regulations and in the Amendment. Rice intended for special markets will not be allowed to be exported unless it conforms to the requirement of those markets.

Under these Regulations the Rice (Export Blending and Grading) Regulations, 1932 and 1933 are revoked.

The Rice (Export Trade) Ordinance, No. 17 of 1935.

This Ordinance provides for the establishment of the British Guiana Rice Marketing Board, a corporate body which may sue and be sued in its corporate name. The Board is to consist of the following members :—

(a) two officers in the public service appointed by the Governor.

(b) five other persons appointed by the Governor-in-Council.

The Board may, with the approval of the Governor-in-Council, appoint a salaried secretary and may employ such other officers and servants as required. An advisory Committee consisting of six persons shall be appointed by the Governor-in-Council to advise the Board on the price of Rice and on all other matters in which the Board may seek its advice. The Board may make regulations to fix the price of Rice, prescribe the form of contract for the sale of Rice, grant, renew or suspend exporters' licences, approve of exporters' agents and generally take action to improve the Rice Trade. The Board is empowered to collect fees which are to constitute the revenue of the Board, out of which expenses shall be defrayed. Specifications are made in regard to the terms of contracts and and licences to export Rice. No person may export Rice unless he holds the Board's licence, nor without the Board's permission sell Rice at a price below that fixed by the Board.

The Rice (Export Trade) Ordinances, Nos. 47 of 1932 and 21 of 1933 are revoked.

Rice (Export Trade) Regulations, 1935.

These Regulations concern the fixing of the prices of export Rice, the granting of credit to buyers and the remuneration payable to exporters' agents. They stipulate the manner in which contract sales may be effected, and provide for the proper appointment of agents. Every bag of Rice for export shall be clearly marked with the grade of the Rice therein.

The Rice Factories Ordinance, No. 26 of 1933.

This Ordinance stipulates that before the erection of a Rice factory a certificate stating that the premises are fit to be used as a Rice Factory, having regard to public health and sanitation, must be obtained from the proper authority. After this certificate is obtained, application may then be made to the Commissioner of the District for a licence for which a fee of $1.00 is payable and which will expire on the 1st of December of each year. Rice may not be manufactured except by the holder of such licence. Where a Commissioner has refused to grant a licence, appeal may be made to the Governor-in-Council. If

a licence is to be transferred, application in writing must be made by the transferor and transferee to the Commissioner. The holder of a licence must keep proper books at the Rice factory showing the quantities of Padi received and the amounts of Rice manufactured and must issue and record receipts for such Padi. During January and July of each year returns showing the matters recorded in these books must be made to the Commissioner. For the purpose of this Ordinance, a bag of Padi and Rice are taken as weighing 143 pounds and 180 pounds gross, respectively.

Authorised persons are empowered to inspect a factory, any Padi or Rice on hand, or any books kept under this Ordinance. It is prohibited for anyone to sell, purchase or receive Padi for the manufacture of Rice except at a price calculated at a bag of 143 pounds gross.

The Rice Factories Rules, 1934.

These rules specify in detail the form of books and receipts to be used under the above Ordinance.

COCONUTS.

The Coconut Products (Control) Ordinance, No. 36 of 1935.

This Ordinance regulates the manufacture and sale of products obtained from the kernel of the Coconut.

PART I.

Coconut Products may only be manufactured by a licenced manufacturer and sold by a licenced broker, the licences to be obtained in each case from the Commissioner of the District, both costing $5.00, and expiring on December 31 of each year. Where application for a licence is refused, appeal may be made to the Governor-in-Council, who may also suspend or revoke licences. Every Copra or Crude Coconut Oil producer shall be registered by the Commissioner of the district, for a fee of 24 cents, and no unregistered person may produce Copra or Crude Coconut Oil. Copra may only be sold through or exported by a broker, and a broker may not sell Copra to any person in the Colony who is not a manufacturer. The Governor may from time to time prescribe the percentage of the quantity of Copra under control of a broker which may be exported during any period of 3 months.

PART II.

A Brokers' Board shall be established consisting of all licensed brokers and two Copra producers appointed by the Governor-in-Council. A Secretary shall be appointed and meetings held once a week. Charges to defray the expenses of the Board shall be fixed by the Board, and not exceed 20 cents per ton of Copra sold. The Board shall at its weekly meetings fix the amount to be advanced by brokers to producers in respect of Copra delivered to the brokers, the amount of this advance being based on the price of Copra as fixed by the Governor-in-Council. The brokerage charge shall be at the rate of 25 cents for 100 pounds of Copra. Proper books shall be kept by brokers showing the

purchases and sales of Copra, and quarterly returns made accordingly to the Commissioner of the district. No person may act as a broker unless a sum of $5,000 is deposited with the Colonial Treasurer or a banker's undertaking given for this amount.

PART III.

The following excise duties shall be levied on Coconut Products manufactured and consumed in the Colony, to wit, 12 cents per gallon of deodorized Coconut Oil and 42 cents per 100 pounds of Lard Substitute. Books shall be kept by manufacturers of Coconut Products, showing the amount and origin of products received and manufactured, and monthly returns made accordingly to the Commissioner of the district. Producers of Copra and Crude Coconut Oil shall keep similar books.

PART IV.

No manufacturer may pay less for Copra than the price fixed from time to time by the Governor-in-Council, nor less than an equivalent price for Crude Coconut Oil, reckoning 100 pounds of Copra = $6\frac{2}{3}$ gallons Coconut Oil. Provision is made to cover cases in which a manufacturer is also a producer of Copra or Crude Coconut Oil. The Governor may prescribe standards of quality and fix maximum wholesale and retail prices within the Colony. Crude Coconut Oil may not be exported except under licence. Provision is made for the examination of samples of Crude Coconut Oil and other coconut products by the Government Analyst. Authorised persons may inspect factories and brokers' premises and examine the books at all reasonable times. No coconut product exceeding 1 gallon or 10 pounds may be removed except by permission of a Commissioner, who may, however, authorise a manufacturer or retailer to remove coconut products from his premises at his own discretion.

Under this Ordinance the Copra Products (Sale and Manufacture) Ordinances, Nos. 31 of 1933 and 23 of 1934 are repealed.

The Coconut Products Rules, 1936.

These rules prescribe the form of licences, certificate of registration, register, books and removal permits called for under the above ordinance.

NARCOTICS.

Tobacco Cultivation (Repeal) Ordinance, No. 4 of 1930.

This Ordinance repeals the Tobacco Cultivation Ordinance, No. 14 of 1912, (Cap. 161) which controlled the cultivation and manufacture of Tobacco.

The Indian Hemp and Datura Ordinance, No. 36 of 1924 and the Opium Ordinance, No. 18 of 1926. (Cap. 190 and Cap. 191):

Under these Ordinances it is unlawful to cultivate the Indian Hemp (*Cannabis sativa* or *C. indica*), Datura (*Datura fastuosa, D. stramonium, D. metel* and their allies) or the Opium Poppy (*Papaver somniferum*).

AGRICULTURAL CREDIT.

The Plantation (Proprietors) Government Loans Ordinance, No. 9 of 1893, (Cap. 158).

This Ordinance gives the right of summary recovery over by one co-proprietor of a plantation paying Government loan (*i.e.* loan made from public moneys under the sanction of the Legislative Council) for another co-proprietor.

The Agricultural Relief Ordinance, No. 20 of 1896, (Cap. 152).

This Ordinance creates a preferent crop lien on the crop or crops to be reaped during the then current year for loans or advances made to the owner of land (*i.e.*, cane plantation and other land cultivated for at least one annual crop) for maintaining cultivation and management, machinery and buildings, purchase of supplies and payment of taxes, etc., when recorded in prescribed form by the Registrar of Deeds. The lender is exempt from obligation to see to the application of the loan, and has a right to inspect the crops pledged. Account must be kept by the owner of the application of the loan. Misapplication of the loan is deemed a felony.

The Rice Growers' Loans Ordinance, No. 2 of 1922, (Cap. 155).

This Ordinance authorises the Colonial Treasurer to advance out of public funds to registered Co-operative Credit Banks any sums not exceeding one hundred and fifty thousand dollars in the aggregate for the special purpose of making loans to Rice growers (whether members or not members of the banks) to be used by the borrowers for reaping, bagging and transporting Padi to the place of storage appointed by the banks. The Ordinance covers on the banks a preferent lien on such Padi, and a bank may sell the Padi, or mill it into Rice and sell it for the recovery of loan and interest together with any expenses of storage, milling and sale, all of which may be recovered by parate execution also. Misapplication of loans is deemed an offence.

The Co-operative Credit Banks Ordinance, No. 28 of 1933.

This Ordinance has been enacted to make better provision for the constitution and management of Co-operative Credit Banks and provides for the appointment by the Governor of a Board, with the Director of Agriculture, Chairman, for the general superintendence of all banks, and a Registrar of banks, who is also secretary of the Board.

Part I of the Ordinance stipulates that a bank which may be registered must be a bank established for making loans to its members for the development of their land or for some other industrial pursuit. Provisions are made for the conditions and acknowledgment of registration, appeal from refusal to register, effect of acknowledgment of registration, incorporation of banks with limited liability, power to acquire land and dispose of property, keeping of register of banks, and cancellation and suspension of registration by the Board.

Part II prescribes (a) Powers and functions of the Board; (b) Status of person appointed to be a member of a committee to represent the Board; (c) Rights and powers of the Board on taking over the management of a bank; (d) Return of management.

Part III deals with the operations of the banks in regard to (a) Loans to banks from public funds; (b) Loans by banks a preferent charge on borrowers' property; (c) Remedy for debts from members; (d) Audit; (e) Report by Board to Government.

Part IV treats of dissolution and winding up of banks.

Part V stipulates offences and imposes penalties.

Part VI enables the Governor to make regulations for giving effect to the Ordinance and prescribing rules for the government of the banks.

The Co-operative Credit Banks Regulations, 1933.

Under these Regulations model rules are provided for the banks.

The Co-operative Credit Banks Regulations, 1937.

These have revoked Rule IX (b) of the Rules for Co-operative Credit Banks in the Schedule to the Co-operative Credit Banks Regulations, 1933, as amended by the Co-operative Credit Banks Reglations, 1936, and substituted a new Rule IX (b) therefor in regard to the disposal of a bank's revenue.

The Co-operative Credit Banks (Amendment) Ordinance, No. 13 of 1938.

This Ordinance amends Sections 2 and 18 (2) of the Co-operative Credit Banks Ordinance, 1933, in certain particulars to restore to the Banks the preferent claim provided under the Ordinance which was affected by the provisions of the Deeds Registry Amendment Ordinance, No. 4 of 1936.

MISCELLANEOUS.

The Public Gardens and Agricultural Shows Ordinance, No. 34 of 1935.

This Ordinance enables the Governor-in-Council to make Regulations concerning the Government Botanic Gardens and Government Agricultural Stations and also with respect to the holding of Agricultural Shows.

The Government Botanic Gardens Regulations, 1936.

These Regulations, made under the Public Gardens and Agricultural Shows Ordinance, provide for the control of persons and vehicles in the Gardens.

PART II.

LEGISLATION RELATING TO INSECT PESTS AND FUNGUS DISEASES.*

The Plant Diseases and Pests (Prevention) Ordinance, No. 37 of 1935, (under which the similar Ordinance, No. 26 of 1920 is repealed) gives the Governor-in-Council power to make Orders and Regulations controlling the importation and exportation of plant material and authorising the necessary measures to deal with outbreaks of Pests or Diseases within the Colony. Importation of plants may also be controlled by orders made under the Customs Ordinance No. 7 of 1884, (Cap. 33).

(A) REGULATIONS AND ORDERS RELATING TO PESTS AND DISEASES PRESENT IN THE COLONY.

The following are issued under the Plant Diseases and Pests (Prevention) Ordinance:—

Plant Diseases and Pests (Notification) Regulations, 1936.

The Governor-in-Council may by order published in the "*Official Gazette*" declare any disease or pest to be a notifiable disease or pest, whereupon, in accordance with the Ordinance, the owner or occupier or person having charge or management of land on which such a disease or pest occurs must notify the Director of Agriculture in writing and must subsequently carry out such steps as the Director of Agriculture may order for the eradication or prevention of spread of the disease or pest. The owner is liable for expenses incurred, though payment of part or all of these may be dispensed with at the Director's discretion. The decision of the Director as to the presence or identification of a notifiable disease or pest is final.

Order in Council No. 550 dated April 2, 1936, published in the "Official Gazette" of April 11, 1936.

By this Order Coconut Caterpillar (*Brassolis sophorae* L.) was declared a notifiable Pest throughout the Colony and Witch Broom (*Marasmius perniciosus* Stahel) was declared a notifiable disease in the North West District of the Colony.

(B) ORDERS AND NOTICES RELATING TO IMPORTATION AND EXPORTION OF PLANTS, FRUITS, SEED, ETC.

Order in Council No. 551 dated April 2, 1936, published in the "Official Gazette" of April 11, 1936.

This Order prohibits the importation into the Colony of Sugar Canes and any plants or parts thereof, of plants of grasses of any kind, and of earth or soil or any packages or coverings which contain or have contained earth or soil. It also

*A summary of Plant Importation and Exportation Legislation in British Guiana and the Caribbean Colonies was published in Agricultural Journal of B.G. IX, 1, p. 25, 1938.

prohibits the importation of banana and plantain suckers without the written authorization of the Director of Agriculture. The provisions of this Order do not, however, apply to importations made by the Director of Agriculture for scientific purposes.

Order in Council No. 552 dated April 2, 1936 and published in the "Official Gazette" of April 11, 1936.

This Order provides that all living plants, seeds, cuttings, bulbs or other plant parts intended for propagation, which may be imported into the Colony, shall be examined by an authorized inspector, who, if he passes the same for importation, shall issue to the Customs Officer a certificate on the recognised form, permitting entry.

Under this Order also, where a certificate of examination is required by the consignee of living plants or plant products exported from the Colony, the same shall be provided on the recognised form by an authorised inspector.

MEDITERRANEAN FRUIT FLY (*Ceratitis capitata*).

Order in Council No. 767 dated May 19, 1930 and published in the "Official Gazette" of May 31, 1930, amended by Order in Council No. 285 dated August 20, 1934 and published in the "Official Gazette" of August 25, 1934.

These Orders, made under the Customs Ordinance of 1884 (Cap. 33) and Amendment Ordinance, 1911, with the object of preventing the introduction of the Mediterranean Fruit Fly (*Ceratitis capitata*) prohibit the importation of fruits (excepting plantains, nuts and preserved fruits) and vegetables (excepting onions, potatoes and preserved vegetables) from all countries except the British Isles, Canada, and the British West Indies, not including Bermuda and the Bahamas, but allow the importation of Pineapples, Yams, Sweet Potatoes, Tannias, Eddoes and Dasheens from Dutch Guiana.

CITRUS.

Order in Council No. 862 dated June 8, 1937, and published in the "Official Gazette" of June 19, 1937 and Order in Council No. 868 dated June 2, 1938 and published in the "Official Gazette" of June 11, 1938.

The first of these orders prohibits the importation into the Colony of Citrus material, including fruit, from the United States of America on account of the danger of introducing Citrus Canker (*Phytomonas citri*) and the second prohibits the importation of Grapefruit from Trinidad and all citrus fruits from the remainder of the British West Indies owing to the presence of Citrus Scab (*Elsinoe Fawcetti*) on Grapefruit in Trinidad, and of Citrus Weevil (*Diaprepes spp.*) in other of the British West Indies.

COFFEE

Order in Council No. 646 dated November 9, 1937 and published in the "Official Gazette" of November 13, 1937.

This Order prohibits the importation of raw coffee from all countries on the continent of South America and from all other countries unless the Director of

Agriculture is satisfied that it is from a country in which the Coffee Berry-Borer (*Stephanoderes hampei*) is unknown.

PIMENTO

Notice No. 852, published in the "Official Gazette" of December 5, 1936.

Owing to the occurrence of Rust Disease of Pimento and of the Bay Tree (*Pimenta acris*) in Jamaica, the exportation of the Pimento Plant or any part thereof, except the dried berries used for commerce, is prohibited in Jamaica, and their importation therefrom into this Colony is prohibited in accordance.

RICE SEED (PADI).

Order in Council No. 422 dated August 17, 1938 and published in the "Official Gazette" of September 24, 1938.

This order prohibits the importation of Rice Seed (Padi) without the written authorisation of the Director of Agriculture

PART III.

LEGISLATION RELATING TO LIVESTOCK, BEES AND WILD BIRDS.

LIVESTOCK—GENERAL.

Pounds Ordinance No. 1 of 1866, (Cap 93)

This Ordinance deals with the impounding of stray cattle and the regulations controlling it.

Pound Fees Rules and Regulations, 1937.

These Rules reduce by 50 per cent. the pound fees payable in respect of wild animals straying on private premises or land, but do not affect the impounding of strays on public premises or land.

Cattle Stealing Prevention Ordinance, No. 3 of 1877, (Cap 94).

This Ordinance deals with the branding of Cattle and the regulations which control it, also with the movement of Cattle on the highways and the control thereof. It also enacts that the skin of any slaughtered Cattle shall be kept for a stipulated period for examination if required.

Cattle Trail (Tolls) Ordinance, No. 16 of 1929.

By this Ordinance the Governor-in-Council may make regulations prescribing the payment of tolls for the passage of Cattle over the Cattle Trail.

Free Importation of Cattle Foods.

Department of Agriculture Notice No. 57 published in the "Official Gazette" of July 10, 1937.

This notice states that under the Customs Duties, 1935, as amended by Section 4 of the Customs Duties (Amendment) Ordinance, No. 26 of 1936, the following cattle foods may be imported free of duty provided that their quality is approved by the Director of Agriculture, to wit: Soya Meal extracted, Linseed Cake, Dried Separated Milk, Meat and Bone Meal, Meat Meal, Fish Meal (white), well known proprietary Calf Meals, Barbados Cotton Seed Meal.

VETERINARY.

The Animals Diseases Ordinance, No. 29 of 1936.

This Ordinance provides for the proper registration of all Veterinary Surgeons. It also states the conditions under which animals may be imported No animal may be imported without permission of an officer appointed by the Director of Agriculture, and any animal so imported, or suffering from disease on arrival, may be destroyed. When disease is suspected in any area of the Colony, the Governor-in-Council may declare such an area to be an infected area and stipulations are made concerning the movements of stock or carcases into, out of or within such areas. Notification of disease must be given immediately to the Police. Diseased animals may be slaughtered, for which the Governor-in Council may award compensation. Special provisions are made as to outbreaks of Anthrax, calling for the inoculation and marking of animals in the area concerned. If Glanders or Farcy recur within two years in the same building, isolation of such building may be required by the Director of Agriculture, and by order of the Governor-in-Council the Colonial Teasurer may recover the cost of isolation or disinfection from the owner of the premises concerned. It is the duty of every Police Constable to enforce the Ordinance. Details are given as to what constitute offences under the Ordinance and the purposes for which the Governor-in-Council may make regulations.

Under this Ordinance The Animals (Breed and Contagious Diseases) Ordinances, No. 5 of 1920, (Cap. 272) and No. 38 of 1932 are repealed.

Exportation of Animals.

The Animals Diseases Regulations, 1937.

These regulations require that no animal shall be exported before it is inspected by the Government Veterinary Surgeon, or a Veterinary Surgeon appointed by the Director of Agriculture and is certified to be free from disease and fit and suitable for export. A scale of fees for inspection is laid down.

IMPORTATION OF ANIMALS.

Order in Council No. 572 dated March 19, 1937 and published in the "Official Gazette" of April 24, 1937.

This Order states the conditions under which importation can be made into the Colony of animals, carcases, fodder or litter from any of the following specified places, to wit: Great Britain, Ireland, Canada, the West Indian Islands, the United States, Brazil, the Argentine, French Guiana, Surinam and Venezuela. All animals and carcases from these places are to be accompanied by a certificate signed by a Veterinary Surgeon on behalf of the Government Department of the country of origin certifying that they are free from disease, and in the case of cattle, that they have passed the tuberculin test. Fodder or litter must be accompanied by a certificate signed by a Veterinary Surgeon of the country of origin certifying that it is from a district free from disease. On arrival in the Colony animals must be certified as free from disease.

BEES.

The Importation of Bees Ordinance, No. 38 of 1935.

This Ordinance permits the Governor-in-Council to make regulations for the purpose of regulating the importation of bees and beekeepers' stock.

The Importation of Bees Regulations, 1936.

These Regulations prohibit the importation into the Colony of (a) honey, combs; (b) hives and other beekeepers' stock which have been previously in use; (c) queen bees; (d) worker bees and drone bees in any stage of development except with the written permission of the Director of Agriculture. Stipulations are made in regard to the manner and quantity in which bees and queen bees may be imported.

The Importation of Bees (Amendment) Ordinance, No. 18 of 1936.

By this Ordinance power is given the Director of Agriculture to destroy or cause to be destroyed any bees or bee equipment imported in contravention of regulations passed by the Governor-in-Council.

PROTECTION OF WILD BIRDS.

The Wild Birds Protection Ordinance, No. 31 of 1919, (Cap. 278) Amended by Ordinance No. 27 of 1934 and by Order in Council No. 701 dated November 5, 1934 and published in the "Official Gazette" of November 10, 1934.

This Ordinance schedules a large number of wild birds for absolute protection, and a smaller number for protection during the close season, from April 1, to August 1, excepting Ibises (Curi-Curi, etc.) for which the close season is January 1, to August 1. It is an offence to kill or injure, or capture or offer for sale any of the birds scheduled. An exception is made in the case of birds killed of necessity in the bush for food, and of Pigeons in the neighbourhood of Rice fields, and Aboriginal Indians are not liable to conviction under the Ordinance.

REVIEWS.

Cacao and Witch Broom Disease *(Marasmius perniciosus)* **of South America.**—*With Notes on other species of Theobroma. Report by Dr. F. J. Pound, Agronomist, Dept. of Agric., Trinidad, on a visit to Ecuador, the Amazon Valley and Colombia, April 1937—April 1938. Pub, Yuille's Printerie, 66 Marine Square, Port of Spain, Trinidad.* (*58 pp.*)

The first part of Dr. Pound's most interesting report deals with the varieties of cacao used for commercial purposes and the search for types resistant to Witch Broom. In a short account of the history of Witch Broom Disease, he points out the havoc played by the disease and the difficulty of economic control with the falling price of cacao, the only practical methods of combating the damage being to improve yields and to discover resistant or immune varieties to replace those at present cultivated. In order to discover such varieties, it was realised that a thorough search must be made in the cacao growing countries of South America and Dr. Pound's journey was the culmination of a good deal of preliminary work done with this end in view.

The search for resistant varieties was finally carried to the Amazon Valley, when it was realised that Ecuador and the Guianas were only outlying areas of this larger and more severely infected region. The types of cacao found in the varying tributaries of the Amazon Valley are described in some detail.

In the lower Amazon, trees were found which were apparently immune if isolated and exposed to bright sunlight, while in the Upper Amazon others were found which were highly resistant and probably immune even under such conditions as might be found on cacao plantations.

The second part of the report concerns the non-commercial species of cacao which occur throughout the region traversed and concerning which there is considerable confusion. Though all the species cannot yet be distinguished with certainty, a number of groups of similar types have been defined, into which most of the known species can be placed, though a few still remain which do not conform to these. The difficulties of correct determination are largely due to lack of adequate material on which to base proper descriptions, and a multiplicity of local names has also added to the confusion.

The third part of the report deals with the method employed to make available for use in Trinidad the Witch Broom resistant varieties that were found. In order to avoid risk of introducing diseased material into Trinidad, seed was sent to Barbados and it is being grown there in quarantine, whence it will be possible to obtain budwood for propagation in Trinidad. The method employed to send the original seed to Barbados is of interest. To prevent fermentation

taking place en route, the mucilage was got rid of by kneading the seed in very dry sand, the mucilage-soaked sand then being removed by hand, after which the seeds were packed in fresh powdered wood charcoal, slightly moist.

E. B. M.

The Principles of Cane Sugar Manufacture BY J. G. Davies. *Pub. Norman Rodger, London, 10/-. (140 pp., 24 plates, 17 figures).*

This book will be very useful to those who are interested in sugar manufacture "amongst other things." Whilst we agree that the cobbler should stick to his last, we sometimes wish that we could drop in on him and talk cobbling knowingly though superficially. But we cannot forget our first visit to a sugar factory, when an overstrained voice shouted unintelligible explanations in competition with the death-cries of a phalanx of noble canes.

The book was obviously written for sugar estate overseers who wish to know what happens after their canes disappear up the cane-carrier, but it will also appeal to many who have to scrutinize factory reports without a very clear idea of what it all means. Some sugar technologists may sneer at it—comparing it with Noel Deerr, Prinsen Geerligs, Browne and Tromp—but it may make them more readily understood when they "talk shop", and they will be able to avoid the awkward task of explaining pH by referring their more inquisitive friends to page 31.

To give an outline of sugar manufacture in 140 pages is an achievement, and the numerous plates and diagrams permit a nodding acquaintanceship which may be developed at leisure into a better understanding.

D. W D.

NEWS.

The Department takes this opportunity of congratulating Capt. F. Burnett. M.C., M.A., on his promotion as Commissioner for Land Settlement in Jamaica, Capt. Burnett was appointed Deputy Director of Agriculture in British Guiana in 1929. The district agricultural work was under his immediate supervision and he rendered valuable assistance in connection with the working of the pure line padi improvement scheme. He also gave a great deal of his time to co-operative schemes in relation to rice marketing and to land settlement problems. He acted on several occasions as Director of Agriculture and as a member of the Legislative Council. He takes with him the good wishes of his colleagues for success in his new appointment.

Consequent on the promotion of Mr. J. D. Gillespie, B.Sc., to be Agricultural Officer, Sierra Leone, the Secretary of State for the Colonies has been pleased to appoint Mr. T. Bell, B.S.A. (Hons.), (Toronto), A.I.C.T.A., to be Agricultural Superintendent in British Guiana. Mr. Bell was the Assistant Manager of the Government Stock Farm and Agricultural Station in Palestine and arrived in the Colony on December 13.

Consequent on the promotion of Mr. H. A. Cole to the Senior Grade, His Excellency the Governor has been pleased to appoint Mr. O. F. J. Churaman, Dip. Agr., to be an Agricultural Instructor as from August 24, 1938.

Mr. L. D. Cleare, F.R. Ent. S., Entomologist, returned from leave of absence on October 21. While on leave Mr. Cleare attended the seventh International Entomological Congress held in Berlin from August 14 to 21.

The Department offers its congratulations to Mr. H. D. Huggins, M.Sc., Dip. Agr., Agricultural Superintendent, on the occasion of his marriage on November 1.

Mr. W. G. Delph, Registrar of Banks, left the Colony on six months' leave of absence on December 5. In consequence, Mr. A. A. Thorne, Accountant, has been appointed to act as Registrar of Banks and Mr. C. A. Lashley of the Treasury Department as Accountant.

Mr. H. Parker, General Manager of Government Rice Mills in the Federated Malay States, who was detailed to investigate the possibility of erecting Central Rice Mills in British Guiana, particularly in Essequibo, and generally to

consider rice milling problems in the Colony, left on October 23, his visit having lasted rather over a month. During his stay in the Colony, Mr. Parker made several visits to rice-growing districts, where he inspected the rice mills and discussed the problems with persons engaged in the industry. He met the Essequibo Coast Committee on several occasions. It is hoped that his report will enable a step forward to be made in the milling end of the industry.

Among the visitors to the Department have been Major G. St. J. Orde Browne, O.B.E., Labour Adviser to the Colonial Office and his Secretary, Mr. R. Norris.

The first quarterly meeting of the B.G. Poultry Association was held at the Department of Agriculture on October 24, a large number of members being present. The President gave an interesting address on the "Production and Care of Eggs" which was much appreciated.

LEGISLATION.

Legislation has recently been enacted prohibiting the importation of rice seed (padi) under Section 3 of the Plant Diseases and Pests (Prevention) Ordinance, 1935.

An Order in Council under Subsection (3) of Section 4 of the Sugar Quota Ordinance, 1937, has recently been passed allocating the quota for the year 1st September, 1938 to 31st August, 1939. The allocations are as follows :

Factory	*Manufacturer*	*Allocation in tons.*
Albion	The Corentyne Sugar Company Limited	13,195
Blairmont	S. Davson & Company, Limited	15,184
Cane Grove	Bookers' Demerara Sugar Estates, Limited	4,221
Diamond	The Demerara Company, Lmited	23,600
Enmore	The Enmore Estates, Limited	10,771
Friends & Mara	The New Friends, Limited	500
Houston	Plantation Houston Sugar Estates Company, Limited	1,799
La Bonne Intention	The Ressouvenir Estates, Limited	9,914
Leonora	The Demerara Company, Limited	10,400
Lusignan	The Enmore Estates, Limited	10,398
Ogle	The Ogle Company, Limited	4,408
Port Mourant	Port Mourant, Limited	13,650
Rosehall	Bookers' Demerara Sugar Estates, Limited	14,698
Ruimvelt	The Demerara Company, Limited	1,600
Skeldon	Bookers' Demerara Sugar Estates, Limited	10,643
Uitvlugt	Bookers' Demerara Sugar Estates, Limited	11,937
Versailles & Schoon Ord.	Plantation Versailles and Schoon Ord, Estates, Limited	4,408
Wales	West Bank Estates, Limited	5,374

PLANT AND SEED IMPORTATION.

Introductions by the Department of Agriculture for the period September—November, 1938.

NAME	QUANTITY.	WHENCE SUPPLIED
Economic.		
Vegetable Seed, 13 varieties	2 lb.	Sutton & Sons (Calcutta).
Vegetable Seed, Assorted	4 lb., 14 oz.	Sutton & Sons, Reading, England.
Onion Seed, 2 varieties	28 lb.	Hamilton & Co., Teneriffe.
Avocado Pears, Guatemala variety	6 seeds	Director of Agriculture, Mauritius.
Rexoro Padi	20 lb.	Dr. G. Stahel, Agrl. Expt. Stn., Paramaribo.
Lettuce, 4 varieties	1 oz each	Ferry-Morse Seed, Co., California.
Ornamental.		
Hyphaene coriacea. Mart	8 seeds	Royal Bot. Gardens, Kew.
,, *parvula*	18 seeds	do.
Pigafetia elata	44 seedlings	Coconut Grove, Palmetum, Florida
Cooperia pedunculata	5 bulbs	American Amaryllis Society, Florida.
Crinum americanum	6 bulbs	do
Lilium catesbaei	18 bulbs	do.
Zephyranthes atamasco	3 bulbs	do
,, *pulchella*	3 bulbs	
,, *treatiae*	1 bulb	
Hibiscus, 18 varieties	126 cuttings	Imperial College of Tropical Agriculture, Trinidad.
Pitcairnia recurvata	1 packet	David Barry & Co., California.
,, *Altensteinii* Lem.	do.	do.
Guzmania species	do.	do.
Flower Seeds, Assorted	4 lb., 3 oz. & 9 pkts.	Hurst & Sons, London.

METEOROLOGICAL DATA—JULY TO SEPTEMBER, 1938.

Recording Stations & Months.	Rainfall. Total Inches.	Number of Days of Rain: Under .10 Inch	.10 to .50 Inch	.50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days	Evaporation Inches	Air Temperature and Humidity: Maximum.	Minimum.	Mean.	Humidity Mean
Botanic Gardens.												
July ...	12.74	7	8	4	1	2	22	4.12	85.1	74.9	80.0	83.6
August ...	14 96	6	7	4	3	2	22	3.86	86.3	75.0	80.6	83.5
September ...	1.85	3	3	1	...	...	7	5.60	88.2	76.8	82.5	80.1
Totals	29.55	16	18	9	4	4	51	13.58	...	...	...	...
Means	...	...	...	...	...	...	...	...	86 5	75.6	81.0	82.4
Berbice Gardens.												
July ...	9.33	6	4	4	2	1	17	...	88.0	74.9	81.4	78.6
August ...	12.63	1	11	4	5	...	21	...	89.7	74.9	82 3	80.7
September ...	.57	4	2	...	...	...	6	...	91.1	76.6	83.8	75.7
Totals	22 53	11	17	8	7	1	44	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	89.6	75.5	82 5	78.3
Onderneeming.												
July ...	10.41	...	11	5	3	...	19	...	85.0	72.4	78.7	92.8
August ...	4.17	5	11	2	...	...	18	...	87.2	73.5	80.1	92.6
September ...	5.59	1	5	1	1	1	9	...	88.4	74.5	81.4	90.9
Totals	20.17	6	27	8	4	1	46	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	86.9	73.5	80.1	92.1
Hosororo, North West District												
July ...	8.04	11	11	4	1	...	27	...	86.5	69.9	78.2	87.8
August ...	17.20	4	8	10	4	1	27	...	70.5	88.4	79.4	89.0
September ...	4.57	9	11	3	...	...	23	...	70.6	89.6	80.1	87.5
Totals	29.81	24	30	17	5	1	77	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	75.9	82.6	79.2	88.1

CURRENT PRICES OF COLONIAL PRODUCE

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XXI, No. 11, Wednesday, 30th November, 1938.

SUGAR.

Per 100 lb. net — 3 lb. per Bag allowed for tare

Dark Crystals for Local Consumption.. ..$3.30
Yellow Crystals do. do. $4.00
White Crystals.. ....$4.75
Molasses Sugar... ....none offering.

Above Prices include Excise Tax of 90c.

RUM.

Imperial Gallon. — Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export)...60c.; Hhds. 52c., Barrels 77c.
White, in Hogsheads—40 to 45 O.P...(for local consumption)..............45 to 55c.

MOLASSES.

Per Imperial Gallon. — Naked.

Yellow (firsts)..10c.
Yellow (seconds)..5½c.

RICE.

Rice............per Bag of 180 lb. gross. Brown Super $3.60—$3.75 ; Extra No. 1, $3.00—$3.25 ; White, None available. Lower Grades $2.25—$2.50 as to quality.
Padi..............per Bag of 143 lb. gross, $1.20—$1.50 as to quality.

GENERAL.

Gold, Raw,..average per oz. $27 to $28.
Diamonds,—*pro rata* as to quality........................average per carat $10 to $11.
Timber, Greenheart, (Lower grade measurements)...40c. to 60c. per c. ft.; for export 72c. to $1.00 per c. ft.
do. Railroad Sleepers—(Mora) ....$1.68 each.
Greenheart Lumber..$70 to $80 per 1,000 feet.
Crabwood Lumber..$60 to $75 per 1,000 feet.
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,......................$4.50 to $6.00 per M.
Charcoal, Capped for shipment..72c. to 85c. per bag.
Firewood..$2.50 per ton.
Coconuts...Selects, $9.00, culls $6.00 per M...Copra $2.00 per 100 lbs. prime Copra.
Balata.......................Venezuelan, none. Local Sheet...36c. to 38c. per lb.
Cocoa..19c. to 19½c. „ „
Coffee..8c. to 9c. „ „

N.B.—Duty Payable on value at time of Importation and rate of exchange on day of arrival.

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AGRICULTURAL JOURNAL

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EDITORIAL.

RICE DEVELOPMENT.

It is seldom easy to persuade a large number of individuals to follow a common course; it is seldom easy even to get them to agree that a common course is worth following. It is no easier when many of those concerned are farmers who, as a class, have never easily sunk their individualities; when, in addition, there are conflicting interests, the task is definitely hard. A case in point is the local rice industry which has found it difficult to organise itself into effective business units for purposes such as milling or marketing. Organisation for these ends has been elusive whether attempted by anybody within or without the industry.

In the economy of the Colony, rice is second in importance to sugar. In most areas, rice, where now grown, has followed second on empoldered areas where sugar was first established. In all areas where both crops are grown, rice is second in importance in providing employment and meeting the charges for essential services; sugar is first. Nor are these the limits of this association. In those areas where the two crops exist together, the problems of rice cause only that amount of concern in the vicinities affected which the troubles of a secondary industry may be expected to arouse. This is the case, generally speaking, in East Demerara, West Demerara and on the Corentyne; on the other hand, where rice exists without sugar, the situation is different—especially in a district such as Essequibo which formerly knew the production of both crops and where sugar, once the mainstay, for one reason or another, goes out of cultivation. Rice is called on there to bear the responsibility in full which formerly it did in part in maintaining the standard of living of the community; in such circumstance, the public hears a good deal of the troubles of rice.

In 1910 there were on the Essequibo Coast 6,471 acres under cane; in 1920 this had fallen to 5,150 acres, in 1931 to 890 acres and in 1936 the last sugar estate, Hampton Court, ceased grinding. In the meanwhile, sugar had disappeared not only from the Coast, but from the whole Essequibo area, for the only other grinding factory—Pln. Marionville on the island of Wakenaam—had gone out of operation in 1930. It was clear that the new situation was having a far-reaching effect on those persons living and having financial interests in Essequibo, and Government appointed a Commission in 1934 to make recommendation as to what should best be done. As rice prices had fallen to uneconomic

levels, the project to which the Commission gave most thought was the keeping alive of the sugar industry in the area but, for financial reasons, Government found it impossible to take this course.

The position in the meanwhile grew worse ; sugar production was restricted and it became difficult for labour from Essequibo to obtain enough seasonal employment on sugar estates in other districts of the Colony.

With the pressing necessity for rice to give the highest possible returns to the cultivator, it seemed desirable that the industry's major problem, milling, be tackled. Thus, last year, a committee was appointed to go into the "feasibility of establishing at Anna Regina or some other central position a central rice mill." Shortly after the committee began investigations, the Secretary of State for the Colonies arranged for Mr. H. Parker, General Manager of the Government Rice Mill, Perak, Federated Malay States, to visit British Guiana to advise on the problems associated with changing over from small scale to large scale milling and to make recommendations with regard to the industry generally. Mr. Parker's report has recently been published as has been the committee's report as Sessional Papers Nos. 3 and 4 of 1939 respectively.

Mr. Parker leaves no doubt as to what his findings are. He expresses himself emphatically. The padi grown in British Guiana, he considers "of excellent quality—far superior to that of Malaya," but of milling the view is different. "The major complaint of the padi cultivator is that he cannot make sufficient profit by its cultivation. Unfortunately all the inefficiencies in handling, milling and marketing tend to reduce that profit. The only solution is for the Government to erect a central mill". Some of the advantages which he points out will result from central milling are :—

(1) Reduction of overhead charges ;
(2) Reduction in fuel costs as construction of boilers will permit burning of padi-husk ;
(3) Uniformity in milling :
(4) Recovery of by-products :
(5) Storage of parboiled padi resulting in controlled output of rice ; forward contracts could then be made ;
(6) Reduction in costs of articles such as bags, etc. which could be bought in wholesale quantities.
(7) Low marketing costs effected by single selling.

The Essequibo Coast Rice Committee's report, like Mr. Parker's, strongly advises the erection of a central mill in Essequibo, the Committee's report discussing in more detail the domestic problems that will arise. Some of the chief recommendations in the Committee's report are :—

(1) That Government provide funds in the form of a free grant for the erection and working capital of a central mill.

(2) That, in the area covered by the central mill, the operation of other mills be prohibited.

(3) That compensation be granted to proprietors of mills which are put out of operation.

(4) That the price of padi be fixed by the central mill at the commencement of each crop.

(5) That the mill make crop advances to land-owners on the basis of contracts for the supply of padi.

(6) That the central mill itself dispose of its rice for export and for domestic consumption.

(7) That Government grant loans to certain land-owner millers in Essequibo to enable them to pay off their indebtedness to merchant creditors in Georgetown.

The Committee makes it clear that after experience has been gained in Essequibo with a central mill, others will and should follow in the several rice producing areas. With the advent of central milling and the more efficient control of the business end of the industry, the future of the Colony's rice industry is thought to be more promising than at any time previously. It would appear that the Essequibo Coast Rice Committee and Mr. Parker have reasoned together with credit to themselves and advantage to an industry which though second in importance to the Colony as a whole is of first and vital importance to Essequibo.

BERBICE AGRICULTURAL EXHIBITION.

Arrangements are now well in hand for the County Agricultural Exhibition which is to held in the Colony House grounds, New Amsterdam, Berbice on Friday, April 14. The success of the effort must depend to a very large extent on the active help given by the agricultural community, but the Exhibition, being a County Show, must largely rely for its support on Berbice.

Efforts have been made to ensure that farmers in all areas are acquainted with the date, the object of the Exhibition and the methods of preparing products for exhibition. No entrance fee will be charged for exhibits and transport facilities are being arranged which, it is hoped, will enable exhibitors to transport their products with the minimum of trouble and expense.

ORIGINAL ARTICLES.

MALARIA IN BRITISH GUIANA.

BY

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PART IV. THE DISTRIBUTION OF MALARIA ON THE COASTLANDS. GENESIS OF MALARIAL EPIDEMICS.

In the previous sections, the life history of *A. darlingi*, the local malarial vector, has been studied and the existence of certain factors ascertained, which tend to limit the distribution of this species and its seasonal incidence. Some of these factors, as water and soil salinity and acidity, influence this mosquito in its developmental stages, and thus limit the extent of its breeding areas ; others, such as atmospheric humidity and air movement, act directly on the adult insect and tend to influence its range of flight and its survival.

We have attributed the uneven distribution of malaria throughout the Colony to variations in these factors. High soil and water salinity or acidity, atmospheric dryness and active air movement are all factors which are inimical to *A. darlingi.* Conversely, soils and surface waters of low salinity and only slightly acid, or neutral in reaction, offer suitable breeding sites ; a humid and quiet atmosphere will allow the adults of this species to fly over a much wider range and will favour their survival for a longer period.

On the West Coast of Demerara the land is sufficiently high to allow natural drainage by gravity. The salt soil belt is very narrow and the cane cultivation and rice beds, with their net of irrigation canals, extend right up to the public road ; high courida (*Avicennia nitida*) and other bush, and the thick groves of coconut palms, mangoes and other fruit trees which mark the nearly continuous ribbon-like village which extends for many miles along the public road, form efficient wind barriers. *A. darlingi* finds suitable breeding and living conditions right up to the sea wall and malaria is more or less highly endemic throughout this whole coastal section.

On the East Coast of Demerara the land is lower, and natural drainage by gravity is not possible ; surplus surface waters must be disposed of by pumping. The front land soils are salt and their surface waters brackish. For this reason these lands are mostly uncultivated and used only for pasturage.

At Ogle the salt front lands extend for approximately 1 mile south of the sea wall ; this belt tends to become broader proceeding eastwards along the Coast.

The malaria rate, which is high on the estates situated nearer Georgetown, tends to fall progressively as the salt belt gets wider, and a larger proportion of the estate population resides in the salt front pastures. (Lusignan, Enmore, Non Pareil).

On the West Coast of Berbice the land is low, and the sea defences less efficient; sea water in many points invades lands situated south of the public road and railway. These are the healthiest coastal localities west of the Berbice Estuary (Lichfield, Bush Lot, Hopetown).

At Bath, the only sugar estate on this section of the coast, between 1934 and 1937, the spleen rate averaged only 8.6, and in 1937 it was as low as 1.5%.

On the Corentyne Coast, as an average, the climate is drier; the locality is notorious for its constant and high breeze. The width of the salt belt runs into miles; the rice fields lying south of the public road are salt and windswept; tree vegetation is very scanty and poor. At Albion and Skeldon the cane cultivation borders on the yards; at Port Mourant nearly 3 miles of rice lands separate the cane cultivation from the estate village. The Corentyne Coast is usually free from endemic malaria.

Diagram No. 1 shows the distribution of malaria, as indicated by the spleen rate, throughout the Guiana Coast—between the Essequibo and Corentyne estuaries—at the end of 1937; the tendency of the rate to fall progressively from west to east is well shown. The average rainfall also shows a similar tendency, there being a difference of no less than 33 inches between the West Coast of Demerara and the Corentyne. No data are available as regards atmospheric humidity and air velocity for a comparative study of these factors throughout the coast; the meteorological observatories of Georgetown and New Amsterdam are both situated on river estuaries. From general experience we believe it is safe to assume that the Corentyne coast is both drier and windier.

It is usually believed in the Colony that the right bank of the river estuaries (Demerara and Berbice) is healthier than the left, and our findings tend to confirm this belief to some extent. On the estuaries, in general, conditions appear to be more favourable than on the coast for the breeding of *A. darlingi*, as the land is relatively higher and less salt, the cane cultivation extending nearly to the river banks. The night atmosphere is also damper, and morning mists are frequent; malaria tends to be highly endemic.

Diamond Estate—on the right bank of the Demerara River, some 11 miles from its mouth—and, to some extent, the village areas situated to the south of this plantation form a very notable and interesting exception which we are at present investigating.

The distribution and incidence of malaria throughout the coast, as shown in diagram 1, can be accepted as what usually obtains under average conditions, but, occasionally, at intervals of 10 or more years, with a general exacerbation of malaria throughout the Colony, severe epidemic outbreaks occur also in

localities which are usually free from the disease, notably on the Corentyne Coast. Similar outbreaks were observed in 1926 and 1938: both these epidemics we ascribe to abnormal meteorological conditions which prevailed during those years, which favoured the breeding of *A. darlingi* even in localities where this species is usually not found.

Let us now briefly examine which are these meteorological factors which favour the multiplication and dispersion of *A. darlingi* and thus give rise to malarial epidemic outbreaks.

Diagram No. 1 shows the average rainfall at various points along the coast at Uitvlugt (1916-36), Ogle (1906-36), La Bonne Intention (1916-1936), Enmore (1913-1936), Bath (1900-37), Albion (1865-1936), Port Mourant (1880-1936), and Skeldon (1906-36).

These averages, from our particular point of view, have relatively little value, as the annual range of deviation is very considerable and irregular. In table I the annual rainfall at Bath Estate, from 1900 to 1938, is shown as an example. One notes that the annual rainfall varied within the extreme limits of 51.83 inches in 1913 and 128.46 inches in 1938.

TABLE I.

ANNUAL RAINFALL AT BATH, WEST COAST, BERBICE, 1900—1938.

Year	*Rainfall in inches*	*Year*	*Rainfall in inches*
1900	85.56	1920	53.12
1901	61.29	1921	74.34
1902	76.38	1922	84.45
1903	92.83	1923	72.04
1904	57.72	1924	74.32
1905	65.73	1925	52.03
1906	89.18	1926	54.17
1907	93.74	1927	104.74
1908	73.94	1928	76.86
1909	66.29	1929	79.08
1910	84.07	1930	81.52
1911	—	1931	69.84
1912	67.53	1932	98.29
1913	51.83	1933	115.30
1914	55.04	1934	67.99
1915	77.25	1935	95.02
1916	89.91	1936	104.35
1917	81.64	1937	87.28
1918	68.38	1938	128.46
1919	72.08		

Annual Average 77.17 inches
Annual Maximum (1938) 128.46 inches
Annual Minimum (1913) 51.83 inches

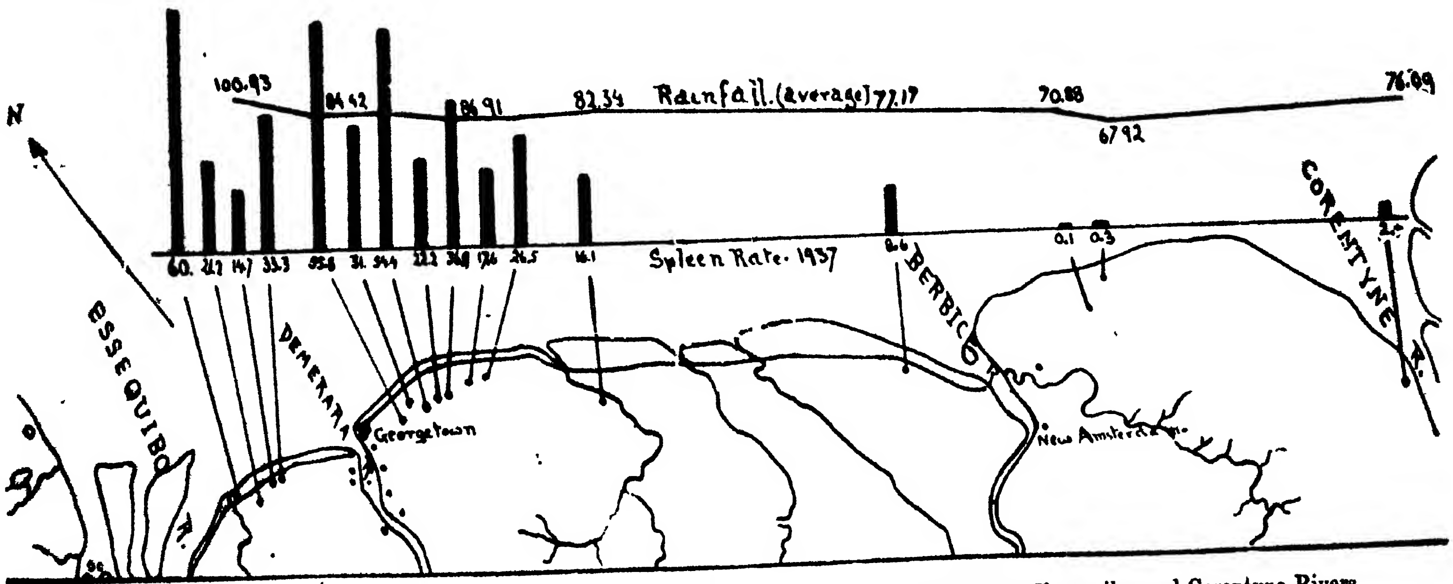

Figure 1.—Distribution of Malaria along the Guiana coast between the estuaries of the Essequibo and Corentyne Rivers. The average rainfall at various points along the coast is also shown. The spleen rates were taken in 1937, i.e., before the unusual epidemic outbreaks of 1938. Note the tendency of the spleen rate to fall progressively from west to east. The Corentyne coast under normal or average conditions is practically free from endemic malaria.

PLATE II.

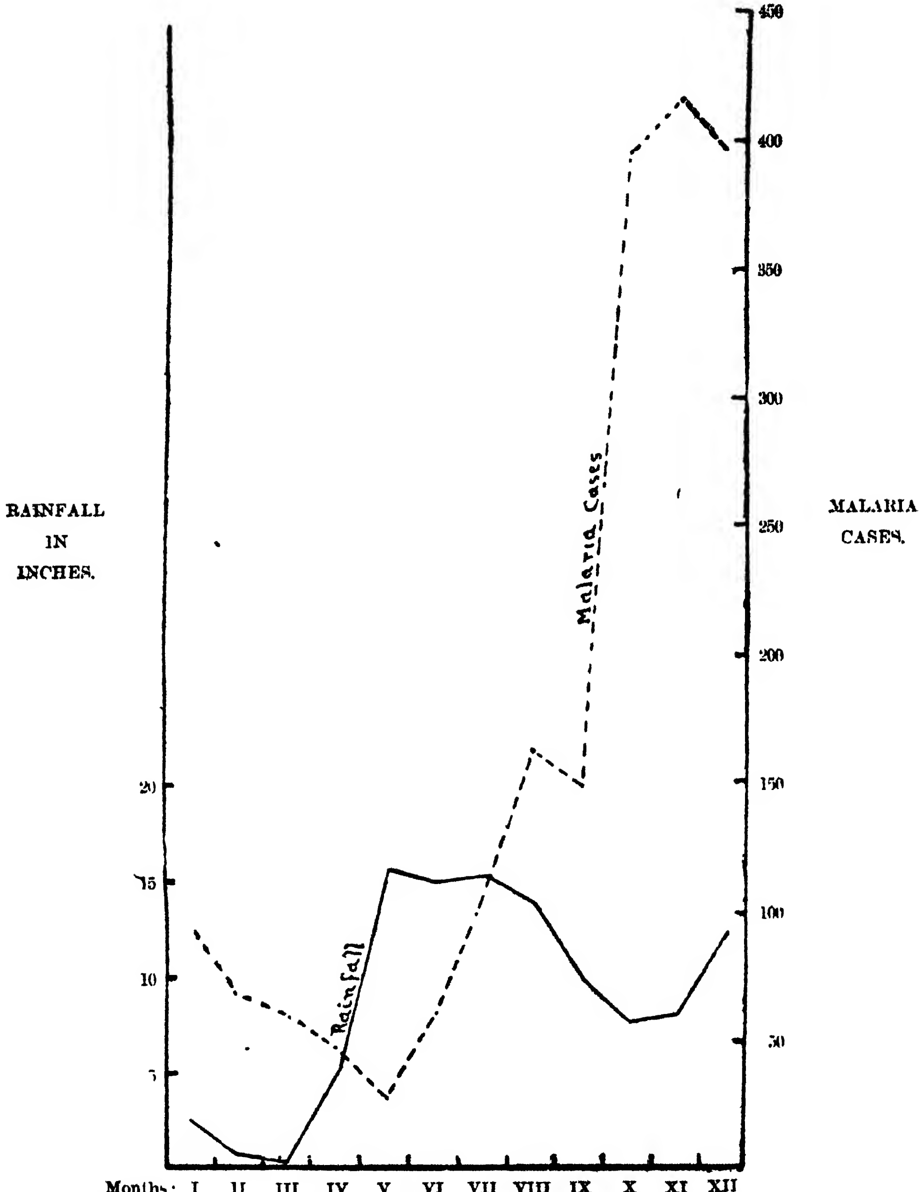

Figure 2.—In the tidal river districts of the interior August and September are usually dry months; the seasonal character of malaria is more distinct than on the coast, as the breeding of the carrier, *A. darlingi*, is mainly dependent on the early summer rains. In 1926 a severe drought was experienced during the first three months of the year, but heavy rains followed lasting from May to September with abnormally high atmospheric temperature. *A. darlingi* appeared in very large numbers and a severe malarial epidemic resulted which affected these districts for the following two years. Our graph illustrates the trend of the rainfall and malaria incidence curves as registered at Mackenzie, on the Demerara River, in 1926.

The total annual rainfall has relatively little importance from a malariological point of view; we find, for instance, that malarial epidemics occurred both in 1926 and 1938 with rainfalls of 54.17 and 128.46 inches respectively; conversely in 1933 with a rainfall of 115.30 inches no epidemic was observed. *The seasonal distribution is what matters.*

Heavy atmospheric precipitation during the late autumn and winter months, when the atmosphere is cooler and the trade winds strongest, is never associated with an increase in the number of Anopheles; on the contrary, such rains appear to influence adversely these insects, and their number rapidly falls, the minimum incidence being observed in February and March.

The incidence of malaria invariably declines during October, November and December, the healthiest months in this respect being February, March and April. The exceptionally heavy rainfall in December of 1933 and January, 1934 which caused disastrous floods did not produce any appreciable rise in the incidence of Anopheles and consequently of Malaria.

Failure of the autumn-winter rains is undoubtedly favourable to the survival of large numbers of *A. darlingi*; a drought at this season is often the prelude to a malarial epidemic later in the year.

The spring-summer rainy season which usually comes on in May and coincides with the period of highest atmospheric temperature and with the fall of the trade winds, always gives rise to active Anopheline breeding. If these rains are steady and continue throughout July and August, and possibly into September, especially if the temperature is unusually high, the breeding of *A darlingi* becomes both extensive and intensive, and the incidence of malaria rapidly rises.

In localities which are usually free from malaria, and where under normal or average conditions, the physio-chemical properties of the surface waters are such as to render them unsuitable for the breeding of *A. darlingi*, the diluting action of heavy and persistent rains may so alter their characters as to transform them into attractive and productive breeding sites. During heavy rains, in July 1938, we found, for instance, *A. Albitarsis*, usually an inland savannah species, abundant and breeding actively in rain water collections situated outside the sea wall at Bel Air.

Observations carried out in the interior, on the Demerara River (1923-1932), indicate that the duration of the period intervening between the onset of the rains and the rise in the incidence of malaria varies in inverse proportion to the height of the atmospheric temperature. A high temperature speeds up both the development of the Anopheles from ovum to adult, and the evolution of the malaria parasite in the Anopheles, *i.e.*, Anopheles breed more rapidly and become infectious in a shorter period after feeding on a suitable malarious subject.

Increased nocturnal atmospheric humidity, which accompanies persistent rains, will favour the survival and flight of *A. darlingi* and thus increase its activity and dispersion.

The ubiquitousness of favourable surface waters—resulting from heavy and persistent summer rains—in close proximity of houses and villages, will greatly reduce the hazards which the Anopheles must face in its long flights to and from its habitual breeding sites, as they will lay their eggs in the nearest suitable waters and return to the houses repeatedly to procure the blood meals they require; a larger proportion of malaria infected Anopheles will, therefore, survive in close proximity of human habitations, and the transmission of malaria inevitably becomes extremely active.

This is the mechanism by which the malarial epidemics of 1926 and 1938 originated both on the coast and in the tidal river districts of the interior.

Diagram II illustrates relations between malarial incidence and rainfall at Mackenzie in 1926.

Diagrams III and IV refer to the malarial epidemics at Skeldon and Bath in 1937 and 1938.

The chronological sequence of the 1938 epidemic outbreaks in Berbice is of special interest: Skeldon, which is situated some 8 miles up the Corentyne estuary, was the first affected; it suffered a mild epidemic in 1937 and again a severe outbreak commencing in June 1938. Albion was the next affected; it suffered both in 1937 and 1938. This plantation is situated further inland than the next, and the yards border on the cane cultivation and on sheltered bush-surrounded rice fields. Port Mourant, which lies further north, in open country, suffered mild epidemics coming on late in August in both years. Bath was only very slightly affected in 1937 and was the last to be involved in 1938. The outbreak on this coastal estate was sharp and short; *A. darlingi* which was extremely abundant in October had practically disappeared in January.

Malaria, unlike other epidemic diseases, cannot spend itself in the course of a few weeks or months; once the infection is acquired, the disease evolves by relapses; even with the complete disappearance of the Anopheline carrier, the consequences of an epidemic continue to be felt for two or three years. Thus the localities of the Corentyne Coast which in 1937 had spleen rates of 2 or 3% now have rates of 32 and 24%; in another locality of the west coast of Berbice, the rate has risen from 1.5 in 1936 to 20.8% in 1938.

If we refer again to Table I, we observe a tendency in the annual rainfall, as registered at Bath, to increase during late years; whereas from 1900 to 1926 atmospheric precipitation reached 90 inches p.a., on only two occasions (1903 and 1907) the maximum recorded being 93.74 inches, from 1927 to 1938, this has occurred no less than 6 times with 104 inches in 1927 and 1936; 115 in 1933 and 128 in 1938.

If this tendency persists malaria will undoubtedly become endemic in many localities which up to the present have enjoyed a remarkable freedom from this disease. This is particularly probable for the West bank of the Corentyne estuary, where the higher level of the land, the low soil salinity, the less active ventilation, the higher atmospheric humidity, the abundance of rice and cane lands coupled with the abundance of bush and tree vegetation, are all conditions of themselves favourable to the presence of *A. darlingi.*

PART V. WHAT MALARIA MEANS TO THE RURAL POPULATION OF THIS COLONY.

The great majority of the rural inhabitants of British Guiana pass their whole existence exposed to the ravages of malaria; they accept the disease as an inevitable necessity. There exists no trace of popular instinct or tradition aiming to avoid the disease by intelligent location of settlements and villages as is usually found amongst indigenous populations of malarial countries.

In the interior only the Aboriginal Indian builds his camp on high ground, on sand or gravel; the immigrant from the coast, of negro, chinese, portuguese, east indian and mixed race, invariably settles and builds his house on the alluvial and intensely forested and malarial mud flats which form the floor of the river valleys.

Such a state of affairs is comprehensible when we consider that the mass of the present day population of the Colony descends from people brought to the country in the past to fill the requirements of the plantations (cotton, coffee, cocoa and sugar) which have always been the main *raison d'être* of the Colony. These people were made to settle on the fertile alluvial plains, and trained to live where they were required. The habit so formed, in the presence of the very peculiar configuration and hydrological regime of the coastlands, has given rise to a rural population of somewhat amphibian customs!

Amongst the more educated classes, both in the country and towns, ordinary practical knowledge about malaria is remarkably deficient; one notes a frequent tendency to camouflage the disease under other names such as "low fever," "biliousness," etc.

Public opinion in general appears definitely apathetic to Malaria which involves scores of thousands of people and causes, directly or indirectly, thousands of deaths every year, whilst it has shown considerable enthusiasm in relation to such relatively minor health problems as tuberculosis and leprosy which cause only an infinitesimal fraction of the mortality, disability and financial loss for which malaria is responsible every year.

It may, therefore, be of advantage to conclude this series of articles by the study of certain statistical data we have collected, which vividly demonstrate what malaria really means to a large section of our rural population and to the Colony in general; and what account must be taken of this particular problem in the framing of any plan or scheme for land settlement and further agricultural development.

Our studies have been limited to the population of the sugar estates, which, in 1937 aggregated close on 68,000 persons, *i.e.*, 35% of the total coastal rural population of the counties of Demerara and Berbice. There is no reason to believe that conditions in the villages in the same areas are in any way better; the contrary is more probably the truth, as the villagers, whilst living in localities similarly and often less favourably placed, do not enjoy the advantages of estate residents in the form of free hospital and medical treatment. The sugar estates, in this connection during the last ten years have spent an average of close on $104,000 per annum on their hospitals only.

In 1938 the sugar estates issued free of charge no less than 422 lbs. of quinine, *i.e.* 27% of the total amount of this drug imported into the Colony in 1937.

Dr. Boyd's recent survey tends to confirm our surmise; one of the highest spleen rates in the Colony was recorded from Lodge Village on the outskirts of Georgetown, and high rates were observed in villages on the East Bank.

It is very difficult to obtain a correct idea of the damage done by malaria from an analysis of morbidity and mortality returns; the great majority of fever cases pass unreported and a great many more are incorrectly diagnosed. Malaria often causes death in its acute form; most of such deaths are undoubtedly registered under the correct diagnosis, but the highest mortality is caused by chronic malaria which entails extensive and varied organic degenerative processes; the clinical picture is complicated and a great many such deaths are registered under diagnoses other than malaria, as for instance, cachexia, marasmus, dropsy, nephritis, debility, senility, etc.

On the sugar estates, an average of 125 out of every 1,000 deaths registered are directly ascribed to malaria; that, in itself, constitutes an alarmingly high rate.

The trend of the *vital index* (1) curve, *i.e.* the ratio of births to every 100 deaths registered per annum, studied in relation to the incidence of malaria, as indicated by the spleen rate, furnishes, we believe, the most reliable index as to the effect of endemic malaria on a community.

We have carried out such an investigation on all the sugar estates of the Colony from the year 1920 to 1937, classifying them in 3 groups (A, B and C) according to their spleen rate as determined in 1937, *i.e.* before last year's epidemics.

Diagram No. V refers to 5 estates (group A) aggregating a population of 20,967 (Plantations Diamond, Bath, Albion, Port Mourant and Skeldon) all of which, under average conditions, are practically free from endemic malaria. In 1937 all these estates had spleen rates ranging from 0.1 to 5%.

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(1) The term "Vital Index" has been suggested by Pearl "to designate that measure of a population's condition which is given by the ratio of births to deaths within a given time." Of this index this Author states: "It may fairly be said that there is no other statistical constant which furnishes so adequate a picture as this of the net biological status of a population as a whole at any given moment." And again: "After much study of it I am convinced that no single figure gives so sensitive a measure of the vitality of a nation or any sub group of people as this does." R. Pearl Introduction to Medical Biometry and Statistics.—1923.

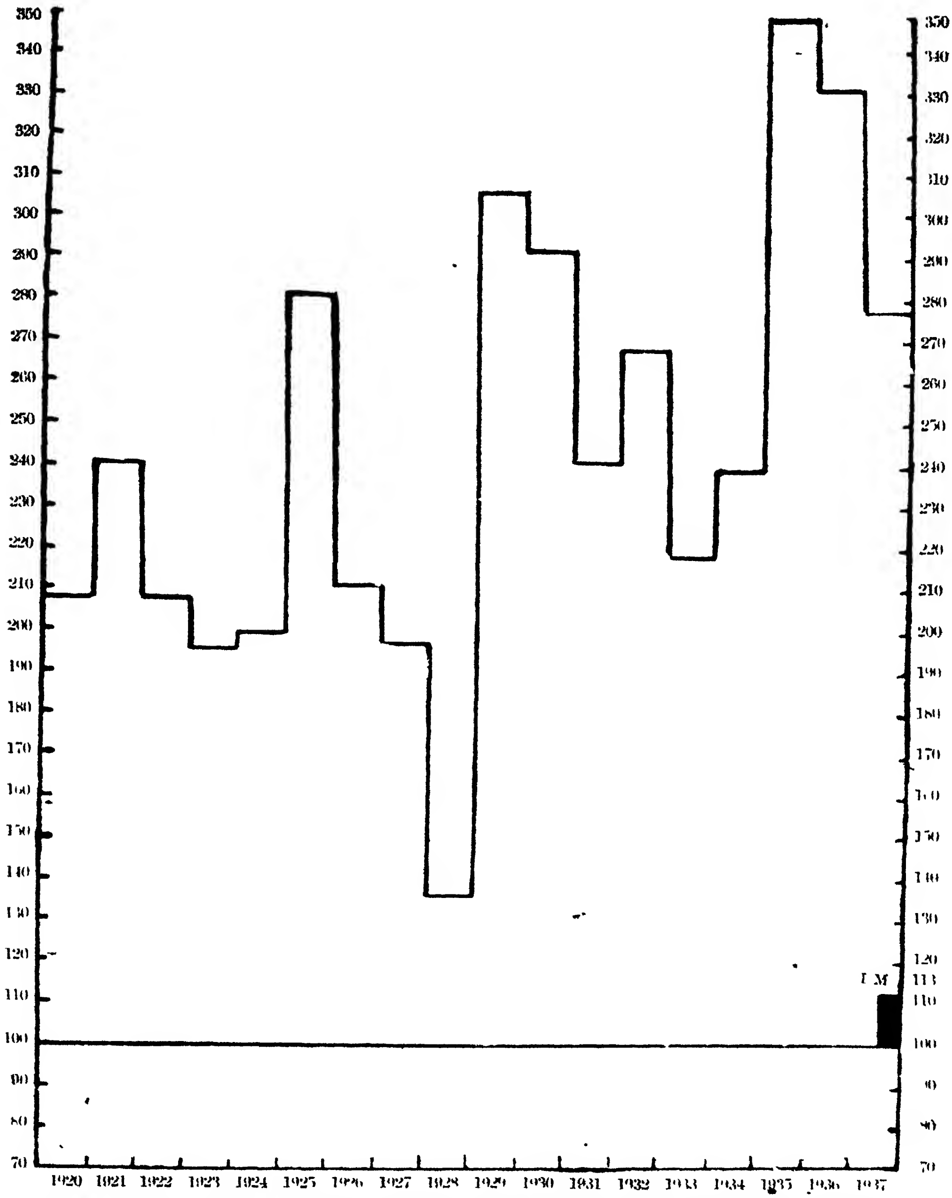

Diagram V.—In this and the two following diagrams, which should be carefully compared, the Vital Index or births to deaths ratio, is studied from 1920 to 1937 over the whole sugar estate population, classified into three groups according to the incidence of malaria as indicated by the spleen rate.

The 100-100 base line indicates 100 deaths; the graph shows the number of births for every 100 deaths registered per annum. When births exceed deaths, the graph runs above the base line; when births are fewer than deaths, then the graph falls below the base line, (see diagrams VI and VII).

The above graph shows the trend of the crude Vital Index on a group of five sugar estates aggregating a population of 20,967, which are free from endemic malaria. As a yearly average from 1920 to 1937 there were 244 births to every 100 deaths, births being constantly and considerably in excess of deaths.

The average annual infant mortality (I.M.) was 113 per 1,000 live births.

PLATE VI.

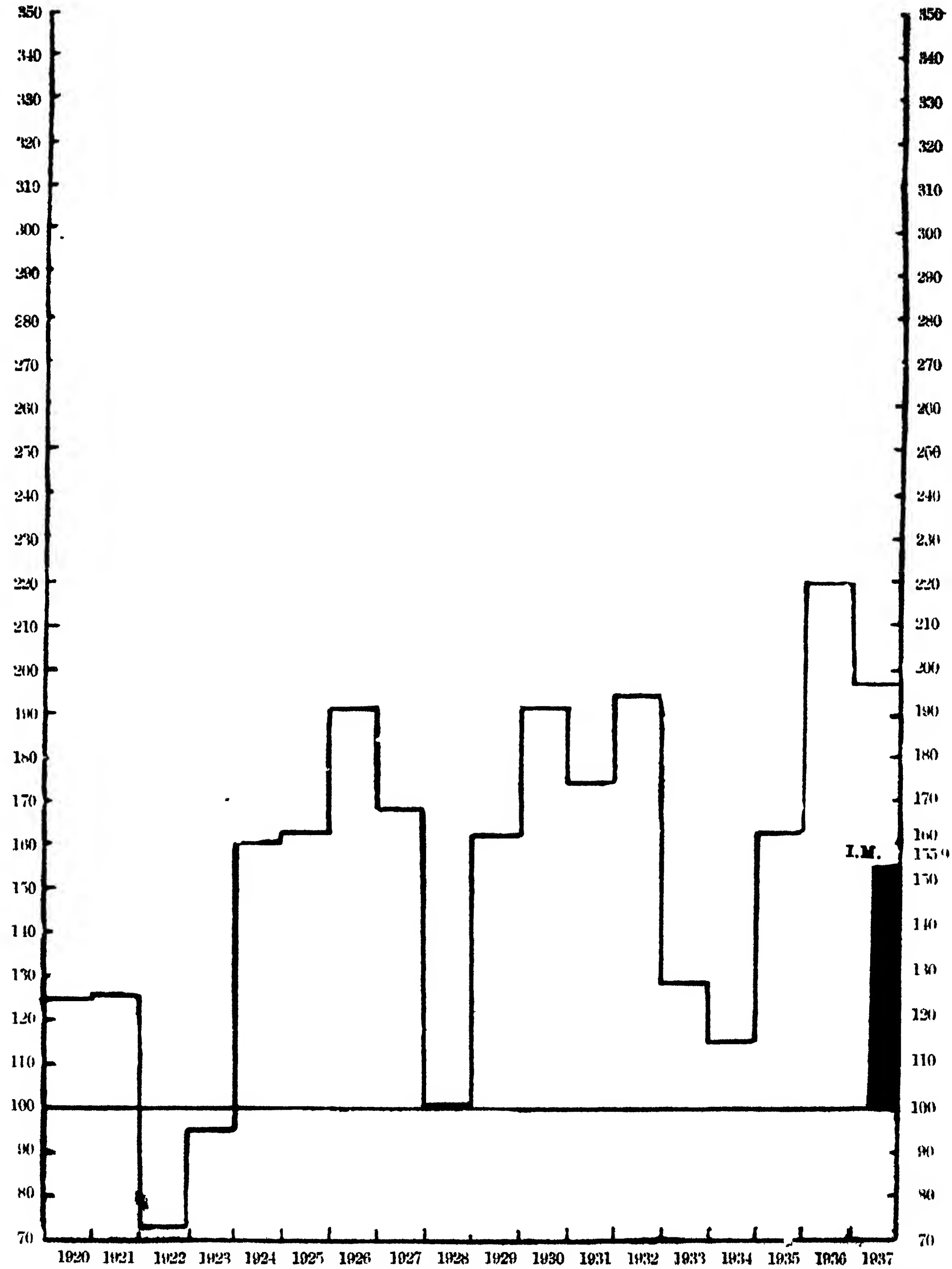

Diagram VI.—Crude Vital Index curve, 1920-1937, from a group of 10 Sugar Estates, aggregating a population of 29,832, which are subject to endemic malaria, (spleen rate from 5 to 30%). As an average for the whole period there were 152 births to every hundred deaths. In two years there were more deaths than births. The average annual Infant Mortality (I.M.) was 155.9.

Throughout the 18 year period covered, the number of births on these estates was constantly and very considerably in excess of the number of deaths; as an average there were 244 births to every 100 deaths. The curve has a very marked upward trend. In the early part of 1926 a severe epidemic of malaria swept the Colony (see Diagram II); it appears likely that this epidemic was connected with the fall in the *vital index* which occurred in 1927 and 1928. In that case we may expect to witness again a similar fall during 1939 and 1940 as a result of last year's epidemics.

Diagram No. VI illustrates the vital index curve from 1920 to 1937 for 10 estates (Group B) aggregating a population of 29,832 (Plantations Uitvlugt, Leonora, Versailles, Providence, Farm, Vryheid's Lust, Non Pareil and Enmore) which are subject to endemic malaria, with spleen rates not exceeding 30%. We observe that the general level of the curve has fallen very considerably (compare with Diagram V). In two years, 1922 and 1923, there were actually more deaths than births and in 1928 the two just balanced. As an average, for the whole 18 year period, there were 152 births to every 100 deaths, *i.e.* a fall of 92 births from the average shown by the non-malarial estates included in Group A.

Diagram No. VII gives the vital index curve from 1920 to 1937 for 7 sugar estates (Group C) aggregating a population of 15,876 (De Kinderen, Wales, Ogle, La Bonne Intention, Lusignan, Blairmont and Providence, Berbice) on all of which malaria is highly endemic the spleen rate being constantly above 30%. The curve shows a fall to yet a lower level when compared to the two preceding diagrams and in five years out of 18 (1921, 22, 23, 28 and 1933) there were more deaths than births. For the whole period, as an average, there were only 119 births to every 100 deaths, *i.e.* a decline of 125 births on the average of the non-malarial estates included in Group A.

In Table II we present certain other vital statistical data, referring to the 1932-37 period and to the sugar estate population of the whole Colony classified according to the spleen rate, as above, into 3 groups, A, B, and C.

TABLE II.

Malaria Rate in relation to birth rate, maternal mortality, infant mortality, and stillbirth rate, annual averages 1932—1937.

Estate Group	A	B	C
Population	20,967	29,832	15,876
Spleen Rate	Under 5%	5% to 30%	Over 30%
Average Annual Birth Rate	32.1	25.0	26.7
Maternal Death Rate	10.6	21.4	21.2
Infant Mortality	113.0	155.9	170.9
Stillbirth Rate	47	78	92

These figures indicate that the population of the malarial areas is less fertile as shown by the decline of the birth rate in parallel with the increase of the spleen rate.

The hazards of child bearing are similarly increased as shown by the twofold rise in the maternal mortality and the stillbirth rate in groups B and C.

The chances of survival of the infants decrease as the malarial rate rises; the same could be said for young children between 1 and 4 years of age.

These diagrams and statistics indicate most clearly how deeply malaria affects a population; its ravages are not limited to the morbidity and mortality it determines; the very vitality of the community is involved and its normal tendency to reproduce and expand inhibited. Such a loss of vitality inevitably reflects itself on the productiveness, *i.e.* on the economic value of both the individual and the community.

In British Guiana, with its peculiar geographical, climatological and exceptional hydrological conditions the malarial problem, as we have shown, presents itself as one of unusual magnitude and with characters which are probably unique; it is intimately connected with the two basic agricultural industries of the Colony.

In spite of such difficulties we feel confident, on the base of our findings, which have revealed certain limitations in the biology of *A. darlingi* which may be exploited to its detriment, that malaria can be successfully controlled if not eradicated in a considerable portion of the inhabited coastland of this Colony.

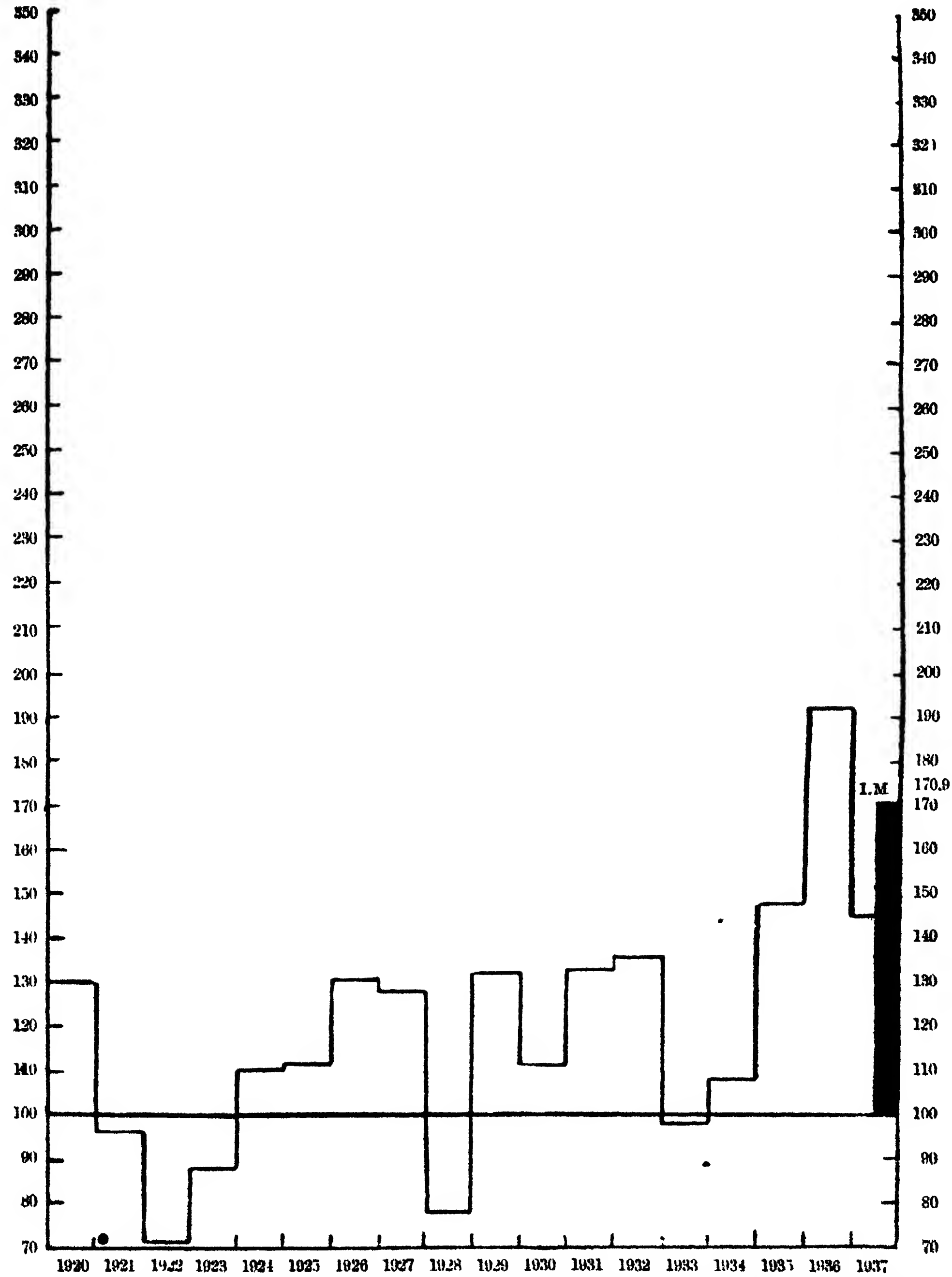

Diagram VII.—Crude Vital Index curve, 1920-1930, from a group of 7 Sugar Estates, aggregating a population of 15,876, which are subject to severe endemic malaria (spleen rate 30 to 60%). As an average over the whole period there were 119 births to every hundred deaths. In five years there were more deaths than births. The average annual Infant Mortality (I.M.) was 170.9 per 1,000 live births.

RESULTS OF PADI VARIETY TRIALS, 1938

BY

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INTRODUCTION.

In the *Agricultural Journal of British Guiana*, Vol. IX, pp. 98–99, an account was given of the variety trials which were laid down for the 1938 Autumn Crop. Fifteen of the older varieties which had been tested in previous years were retained, some to be used as controls, others to be given a final test. Thirty-four varieties which had passed through the progeny rows at the Georgetown and Henrietta Experiment Stations, for purification and preliminary yield testing, were considered promising enough for trials; seven of these were hybrids bred at the Georgetown Station. Three varieties found in mixed cultivations in the Corentyne District, were also included.

The sites of these variety trials were as follows:

Berbice:	Whim and No. 70	Under the supervision of Mr. J. D. Gillespie, Agricultural Superintendent, and later, of Mr. E. M. Morgan, Asst. Agricultural Superintendent.
	W/C, Berbice	Under the supervision of Mr. E. M. Morgan, Asst. Agricultural Superintendent.
Demerara:	Georgetown Rice Station.	Under the supervision of Mr. E. M. Peterkin, Agricultural Superintendent.
	Vreed-en-Hoop	Under the supervision of Mr. E. G. Benson, Agricultural Superintendent.
Essequibo:	Henrietta	Under the supervision of Mr. A. A. Abraham, Agricultural Superintendent.

Two classes of trials were laid down—Class A (Standard) and Class B (Individual District). The purpose of the Standard trials was to test the more promising varieties in all the districts, while the Individual District trials contained certain additional selected varieties which it was considered desirable to test in different districts.

CLASS A (STANDARD) TRIALS.

Six Class A trials, two of long-grained varieties and four of medium-grained varieties, were laid down at each of the stations Georgetown, Henrietta and Whim. Long-grained controls (Demerara Creole and D 221) and medium-grained controls (D 99 and D 114) were included in each group. Unfortunately at Whim, the water supply failed at flowering time, so that five of the trials had to be discarded on account of the very poor or no yields obtained.

The trials consisted each of five randomised blocks, containing nine, ten or eleven varieties in each block.

The results are presented in Tables I and II.

TABLE I.

Results of Class A Variety Trials at the Georgetown Station.

LONG GRAINED VARIETIES				MEDIUM GRAINED VARIETIES							
Trial 1		Trial 2		Trial 3		Trial 4		Trial 5		Trial 6	
Variety	Yield per acre lb.	Variety	Yield per acre lb.	Variety	Yield per acre lb.	Variety	Yield per acre lb.	Variety	Yield per acre lb.	Variety	Yield per acre lb.
D 114*	3,616	D 99*	3,248	D 99	4,032	D 110	2,976	D 257	3,816	D 114	3,240
D 99*	3,568	D 91	3,144	Unity	3 616	15 37	2,936	D 256	3,696	D 115	3,160
D 259	3,568	D 221	3.056	D 162	3,616	D 221**	2,920	D 99	3.688	D C.**	3,104
Jaisingh	3,360	D114*	3,056	D.C.**	3,568	D 258	2,896	D 114	3,688	D 221*	3,040
Kalyaman	3,248	Kalyaman	3,056	D 94	3,480	D.C **	2,752	D 250	3,640	D 99	3,032
D 253	3,216	29—37	3,016	D 109	3 456	D 114	2,720	D 116	3,512	23—37	2,992
D.C.	3,168	13—37	2,880	D 114	3,392	D 99	2,680	D 255	3,424	19—37	2,792
D 251	2,968	D.C.	2,688	D 221**	3,224	No. 79	2,656	D 221 *	3.376	18—37	2,736
D 254	2,952	Seymour S.	2,616	D 193	3 216	D 262	2,216	D 247	3.272	Blue Stick	2,720
Padi Berbice	2,768	Nickerie	2,616	D 108	2,488	D 261	1,728	D.C.**	2,840	17—37	2,688
		Patna						D 246	2,784		
Sig. Diff. P=.05	333	—	—	—	435	—	319	—	231	—	—

Medium-grained varieties.

**Long-grained varieties.

TABLE II.

RESULTS OF CLASS A VARIETY TRIALS AT THE HENRIETTA STATION.

Long Grained Varieties						Medium Grained Varieties					
Trial 1		Trial 2		Trial 3		Trial 4		Trial 5		Trial 6	
Variety	Yield per acre lb.	Variety	Yield per acre lb.	Variety	Yield per acre lb.	Variety	Yield per acre lb.	Variety	Yield per acre lb.	Variety	Yield per acre lb.
D 99*	4,248	D 99*	4,212	D 99	4,088	D 99	3,476	D 99	4,160	D 99	3,480
D 114*	4,196	D 114*	3,928	D 94	3,604	D 114	3,260	D 257	3,768	D 114	3,212
Jaisingh	4,076	Kalyaman	3,700	D 114	3,412	No. 79	2,896	D 255	3,724	19–37	3,036
D 259	3,884	Nickerie Patna	3,604	D 109	3,340	D 258	2,856	D 247	3,696	D 11	2,764
		D 221	3,600								
Kalyaman	3,780	D.C.	3,228	D 162	3,264	D 221	2,548	D 116	3,644	17–37	2,708
D.C.	3,704	D 91	3,224	Unity	3,172	D.C.	2,516	D 250	3,592	23–37	2,696
D 251	3,560	29–37	3,140	D 221**	3,048	15–37	2,484	D 256	3,576	D 221 **	2,660
D 254	3,552	13–37	3,104	D 108	3,032	D 110	2,296	D 114	3,560	18–37	2,600
D 253	3,484	Seymour S	3,008	D 193	2,928	D 262	2,120	D 246	3,536	D.C.**	2,588
Padi Berbice	3,292			D.C.**	2,908	D 261	1,892	D.C.**	3,204	Blue Stick	2,492
								D 221**	3,128		
Sig. Diff. P=.05	247		208		240		288		235		—

*Medium-grained Varieties.

**Long-grained Varieties.

In the six trials at Georgetown, shown in Table I. the following results were obtained:

Trial 1: The four leading varieties are D 114, D 99, D 259 and Jaisingh. The remaining six varieties are significantly inferior, except Kalyaman which is inferior to D 114 only.

Trial 2: This trial yielded no significant result.

Trial 3: D 99 was easily the leading variety, while D 108 was definitely the worst. Unity and D 162 were very nearly significantly inferior to D 99, but were not superior to the rest.

Trial 4: Apart from D 262 and D 261, which were definitely the worst varieties, there was very little to choose between the varieties in this trial.

Trial 5: D 257, D 256, D 99 and D 114 were definitely better than the last five varieties in the list. Demerara Creole and D 246 were significantly inferior to the remaining nine varieties.

Trial 6: This trial yielded no significant result.

From the variety trials at Henrietta, shown in Table II, the following conclusions may be drawn:

Trial 1: The leading varieties were D 99, D 114 and Jaisingh, these being significantly superior to the rest, except D 259 which was exceeded only by D 99.

Trial 2: D 99 was significantly superior to D 114, which in turn was significantly superior to the rest. Kalyaman, Nickerie Patna and D 221 followed with significant superiority over the others.

Trial 3: D 99 again proved the best variety. D 94 and D 114 came next, but D 94 alone was significantly superior to D 109 and D 162.

Trial 4: D 99 and 114 led in this trial, both being significantly superior to the others. No. 79 and D 258 showed no difference between themselves, but both were significantly superior to the rest.

Trial 5: D 99 once more came ahead of the other varieties. The remainder were bracketed together, with the exception of Demerara Creole and D 221 which were significantly the worst.

Trial 6: D 99 led again, with D 114 and 19—37 coming second, both proving significantly superior to the rest.

The one Class A variety trial from Whim (a trial with medium-grained varieties) gave the following results:

TABLE III.

Variety	Yield per acre lb.
D 255	4,244
D 256	3,812
D 221	3,708
Demerara Creole	3,568
D 247	3,512
D 114	3,108
D 246	3,048
D 116	2,816
D 250	2,416
D 99	2,238
Sig. Diff. P = .05	523

D 255 and D 256 were the leading varieties, D 221, Demerara Creole and D 247 followed, but only D 221 was significantly superior to the remaining varieties.

CLASS B (INDIVIDUAL DISTRICT) TRIALS.

These trials were laid down at Henrietta (Essequibo), Vreed-en-Hoop (West Demerara) and No. 70 and W/C, Berbice (Berbice). The trial at Henrietta contained selected long-grained varieties, tested against D 114 as control; the trial at No. 70 contained old varieties and three varieties local to that district.

The results are shown in Table IV.

TABLE IV.

Results of Class B Variety Trials.

Henrietta		No. 70		W/C, Berbice		Vreed-en-Hoop	
Variety.	Yield per acre, lb.	Variety.	Yield per acre, lb.	Variety.	Yield per acre, lb.	Variety.	Yield per acre, lb.
1—1	3,020	D 97B	4,088	D 114	2,884	D 114	3,424
D 114	2,952	No. 79	3,980	D 115	2,848	Jaisingh	3,256
18—4	2,760	D 114	3,902	D 110	2,660	D 99	3,232
Seymour S	2,736	Benab No. 79	3,888	D 99	2,432	D 110	3,192
25—5	2,704	Kalyaman	3,848	D.C.	2,392	D 116	3,112
Jaisingh	2,648	Babylon 1	3,664	D 221	2,244	D 115	3,072
17—3	2,592	D 115	3,424	D 116	2,196	Seymour S	2,872
22—2	2,468	Benab No. 1	3 344	Kalyaman	2,136	D.C.	2,864
Ramjess	2,352	D 99	3,208	No. 79	2,048	Kalyaman	2,816
Sue	2,316	D 116	3,196				
Sig. Diff. P=.05	326		420		—		279

From these, the following conclusions may be drawn:

Trial 1: At Henrietta, the first five varieties, 1—1, D 114, 18—4, Seymour S, and 25—5, showed no significant difference between themselves, but of these, 1—1 alone was significantly superior to the six last varieties in the list. Sue was definitely the worst variety.

Trial 2: At No. 70, there was no significant difference between the first five varieties, D 97 B, No. 79, D 114, Benab No. 79 and Kalyaman, but D 97B was significantly superior to the last five varieties listed.

Trial 3: The trial at W/C, Berbice yielded no significant results.

Trial 4: At Vreed-en-Hoop there was equality among the first four varieties D 114, Jaisingh, D 99 and D 110: of these D 114 alone was significantly superior to the five varieties at the end of the list.

CONCLUSIONS.

A consideration of the present results and those obtained in previous years leads to the following general conclusions:

1. Judged from the yield standpoint only, D 114 is the best of all the varieties available. If certain milling difficulties can be overcome this variety will prove very valuable to grower and producer alike. It has been compared with Demerara Creole, No. 79 and Blue Stick on many occasions with the following results:

In 42	trials	it	outyielded	Demerara Creole	by	404.36	lb.	per	acre.
,, 36	,,	,,	,,	No. 79	,,	318.80	,,	,,	,,
,, 18	,,	,,	,,	Blue Stick	,,	288.67	,,	,,	,,

2. No well-tested long-grained variety as yet offers as a substitute for Demerara Creole.

3. D 99, D 109 and D 110 are heavier yielders than the standard medium-grained varieties No. 79 and Blue Stick, and are worthy of commercial consideration. In the meantime they are being examined as to drought resistance, a characteristic of No. 79. D 99 has a longer vegetative period than No. 79.

4. The following varieties should be tested further:

Long-grained.	*Medium-grained.*
D 116	D 94
D 253	D 162
D 254	D 246
D 259	D 247
29–37	D 250
Jaisingh	D 255
Nickerie Patna	D 256
	D 257
	Unity

5. The following varieties may be dropped from further trials:—

D 91	D 251	15-37	Padi Berbice
D 108	D 258	17-37	Seymour
D 115	D 261	18-37	Kalyaman
D 193	D 262	19-37	
D 221	13-37	23-37	

ACKNOWLEDGMENT.

Thanks are due to the Director of Agriculture, the Deputy Director of Agriculture (Acting) and the Sugar Agronomist and Plant Breeder for their views and suggestions as to the presentation of these results.

RESULTS OF RECENT EXPERIMENTS WITH SUGAR CANE

BY

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The results of a large number of variety and manurial trials with cane, harvested during the last six months of 1938, have been printed in an abbreviated form and distributed locally to sugar estates and managers and others intimately connected with the industry. The data will appear and be fully discussed in *Sugar Bulletin No. 8*, which is due to be issued about July, and will deal with the experiments harvested during the year ending June 30. In the meantime, however, attention may be drawn to some of the points which have emerged.

Of the canes which have been harvested as plants, first and second ratoons, Co. 213 has been well tested and considerable reliance can be placed on its position with regard to the standard canes. Some estates are making commercial tests of this cane, which appears to be an economic sugar producer, and others are advised to do likewise. D. 49/30 and D. 66/30 have also been fairly well tested. Though neither is likely to outyield P.O.J. 2878, the former may be expected to outyield Diamond 10. More experimental data are being sought from P.O.J. 2753, D. 50/30, D. 75/30, D. 67/30 and D. 150/30 which all continue to show promise. In the meantime nurseries of these canes should be established and extended.

D. 419/33 (Co. 281 x Diamond 10) heads the list of canes reaped only as plants and first ratoons. It has been harvested twice as a plant and once as a first ratoon and promises to be satisfactory both as regards cane yield and juice quality.

Of the seedlings harvested in plant cane trials only, D. 552/33 (D. 219/30 x Diamond 10) and D. 166/34 (P.O.J. 2878 x Sorghum) are worthy of note. The former, in a single test, gave eight tons of cane per acre more than P.O.J. 2878 and a juice just slightly inferior to that of the standard. D. 166/34, a variety which has been outstanding in the nurseries at Sophia, has given the following average plant cane results in two experiments (La Bonne Intention and Leonora) where it was compared with Diamond 10:

Variety.	Cane, Tons/acre.	Sucrose, % Cane.	Glucose Ratio.	Juice Purity.	Sucrose, Tons/acre.
D. 166/34	48.67	14.62	7.22	88.0	7.11
Diamond 10	39.94	14.60	6.53	90.1	5.82

The fertiliser results may be summarised as follows :—

1. Further confirmation is reported as to the sulphate of ammonia requirements of frontland, *i.e.*, 2 cwt. per acre for plant canes and 4 cwt. each for first, second and third ratoons. Increased evidence is available in support of much heavier dressings of nitrogen (probably of the order of 120-140 lb. per acre for both plants and ratoons) for pegassy clays and such applications are likely to yield a profit. If, however, they are given in the form of sulphate of ammonia (5-6 cwt. per acre), a dressing of one ton of limestone at every replanting seems essential if the useful life of these already very acid soils is not to be endangered.

2. Nicifos (18 : 18) was tested on first ratoons at five pegassy clay sites and on plant canes at four frontland sites. It increased first ratoon yields in Field 36 S.D., Cane Grove, where it had had an excellent effect in the plant canes, and the total difference in its favour for two crops is impressive. The area is deficient in phosphate and the result is probably due to none of the other fertilisers being accompanied by phosphate. Thus in Field 10 C., Wales, where both trial sites were somewhat deficient in phosphate, it did not differ significantly from nitrochalk plus basic slag in effect on the plant canes or first ratoons. Similarly in Fields 64 and 70 Z., Uitvlugt, it was not better than nitrochalk plus basic slag for plant canes and on first ratoons it proved inferior in Field 64 Z and of equal merit in Field 69 Z., Uitvlugt. Nicifos was compared with sulphate of ammonia and nitrochalk four times with plant canes on frontland. It did not produce a significantly different yield in any instance but at Leonora the canes from the nicifos plots were sweeter than those from the sulphate of ammonia plots but not than those of the nitrochalk treatments.

3. Nitrochalk was tested with first ratoons five times on pegassy clay and with plants four times on frontland. On the pegassy clay the yields did not differ statistically from those given by nitrogen-equivalent dressings of sulphate of ammonia, thus confirming the plant cane results where in only one out of five instances was there any difference. Further, in combination with basic slag, it proved as efficient or more so than nicifos for both plants and ratoons. On frontland there was no significant difference between the effect of nitrogen-equivalent dressings of nitrochalk and sulphate of ammonia on plant cane yields. At Leonora, however, nitrochalk gave a definitely sweeter cane than sulphate of ammonia.

It has been proved that the cane soils of the Colony are rapidly becoming more acid and that the process is accelerated by the increased use of sulphate of ammonia. On the other hand, it is clear that heavy nitrogen applications are economically sound and the compromise has been suggested, and largely adopted, of supplying the nitrogen in the

form of sulphate of ammonia and applying a dressing of one ton of limestone per acre at each replanting to counterbalance the acidifying effects of the sulphate of ammonia.

A possible alternative procedure would be to employ a nonacidifying nitrogenous manure, and it now appears that nitrochalk is deserving of careful consideration and commercial tests by the sugar estates. This manure contains a lower percentage of nitrogen than does sulphate of ammonia and more would have to be used to obtain a nitrogen-equivalent dose, the proportion being roughly four of nitrochalk to three of sulphate of ammonia. Since the two fertilisers are quoted at approximately the same price per ton in England, it follows that the ratio of cost would also be in like proportions. On the other hand yields are the same from nitrogen-equivalent doses of the two fertilisers and at first one may be tempted to forego what appears to be a considerable increase in cost (3 : 4) for no immediate gain. If, however, consideration is given to the fact that with the sulphate of ammonia one should buy and apply a ton of limestone at every replanting whereas the nitrochalk will not acidify the soil but, on the contrary, supply it with a considerable amount of calcium carbonate, the true increase in cost from the use of nitrochalk will be seen to be negligible.

It is suggested that each estate take *several* fields through a complete cycle using only nitrochalk as a nitrogenous manure, and that where the estate possesses both soil types several fields in each area should be so treated.

4. Nitrate of soda appeared in five first ratoon trials on pegassy clay. In the plant canes it had not given statistically different yields from nitrogen-equivalent doses of sulphate of ammonia or nitrochalk. In the first ratoons it proved equivalent to sulphate of ammonia in all five trials but was definitely inferior to nitrochalk in one out of the five (Field 36 S.D., Cane Grove). On the whole it seems a less likely substitute for sulphate of ammonia than does nitrochalk.

5. Superphosphate of lime had no effect on the yield of first ratoons (Field 20R.) at Port Mourant but had a definitely adverse effect on juice purity. It will be remembered in this connection that a medium dose of this fertiliser had an adverse effect on the sucrose content of the plant canes in Field 23 R., Port Mourant. The plots in this field were tested as first ratoons for any residual effect of the plant cane phosphatic dressings but there was none. Phosphatic applications cannot be advised for this portion of the estate. On second ratoons, superphosphate of lime had no effect in Field 81 R.H., Rose Hall, but a medium dose definitely increased cane yield in Field 26 Rp., Blairmont. As in the case of sulphate of potash there was no effect on yield in the two earlier crops and the present result appears to be the cumulative effect of three dressings.

6. Sulphate of potash had no significant effect on second ratoons on frontland at Rose Hall (Field 81 R.H.,) but gave a definite increase in second ratoon yield on Field 26 Rp., Blairmont. In the latter field there had been no effect on plant cane or first ratoon yields. It seems that the present result is the cumulative effect of three applications and that potash-fixation by the soil may be involved. On first ratoons at Port Mourant there was no residual effect from plant cane applications (Field 23 R.) or from applications to first ratoons only (Field 20 R.)

7. Manganese ore, from a local deposit, was tested on a pegassy clay. It had no definite effect on the plant cane yield but adversely affected the juice purity.

CATALOGUE OF THE LEPIDOPTERA RHOPALOCERA (BUTTERFLIES) OF BRITISH GUIANA

BY

ARTHUR HALL, F. R. Ent. S.

INTRODUCTION.

British Guiana is, with the exception of India, the richest of all the British Dominions in Lepidoptera, but it is remarkable how little has been written about them. When attempting to obtain information on the subject previous to my first visit to the country in 1929 I was only able to discover isolated records of the butterflies scattered through all sorts of books and periodicals of various dates covering more than a century. Many of the species described by the older authors with such vague localities as "Guiana" and "South America" may have come from our Colony, and the very large number recorded and figured in the classic work of Cramer as long ago as 1779–1791 from the neighbouring Dutch settlement of Surinam gives some idea of what we may expect to find in British Guiana. But the very few competent entomologists who have visited the latter country have contented themselves with collecting specimens without leaving any account of their expeditions and in view of the rapidly increasing number of scientific travellers who now come to British Guiana and the great importance recognised as attaching to geographical distribution and variation it has been thought that a preliminary Catalogue of the Rhopalocera known to inhabit the Colony is desirable. As one would expect from the nature and situation of the country the butterfly fauna of British Guiana is mainly that of the great Amazonian Region with a slight but distinct admixture of Venezuelan elements. It has, however, a number of interesting peculiarities of its own. A feature which it shares with the lower Amazon is the great abundance of *species* as compared with the comparatively small number of *individuals*. Migratory swarms of such species as *Catopsilia statira* and the moth *Urania leilus* are not infrequent, especially along the rivers but with these exceptions one rarely meets with those large masses of butterflies so often to be seen in hilly districts even in temperate regions and it is sometimes possible to walk a mile or more in the Guiana forest without seeing any butterflies at all except perhaps a few small *Satyridae*. On the other hand in favourable localities the collector can easily obtain over a hundred species within two or three days and hardly a day passes without yielding something which he has not met with before. Although the following catalogue includes well over seven hundred species the fact that many species, particularly of the smaller kinds, which are known from Dutch Guiana have not yet been recorded from our side of the frontier renders it certain that many more remain to be discovered and inasmuch as the whole southern half of British Guiana from

Tumatumari to the Brazilian frontier is practically unexplored by the lepidopterist, it would not be surprising if the number of butterflies occurring within the Colony should ultimately be found to exceed one thousand species. In a country having a land frontier on three of its four sides and without marked physical differences from the adjacent territories no great number of peculiar forms can be expected, but there is nevertheless a small number of species and sub-species which have not hitherto been recorded from anywhere else. One of the most historically interesting of these probably peculiar species is *Heliconius hecale*. This was figured by Cramer in 1774 under the name of *Papilio pasithoe* from "Surinam", but no collector for more than a century has met with it anywhere east of the Demerara River and as the Dutch Colony at the time when Cramer's work was published included the present counties of Berbice and Demerara it not only seems probable that his specimens came from what we now know to be its area of distribution, that is, the area between the Demerara and Essequibo Rivers, but it gives rise to the interesting speculation as to whether many of Cramer's other Surinam species may not have come from what is now British Guiana.

Amongst the different families of butterflies the *Danaidae*, amongst which are now included the transparent and mimetic *Ithomiinae* are in rather small numbers (35 species), as is also the case on the lower Amazon. The *Satyridae* with 45 species are fairly well represented and the *Brassolidae* although often unnoticed on account of their crepuscular habits, have 15 species, a rather larger number than in most of the adjacent countries. The seven species of *Morpho* is a large number for such a small area, and these of course never escape the notice of all those who visit the forests.

In the great family of *Nymphalidae* the *Heliconiinae* are the most often noticed owing to their bright colours and abundance in individuals but the *Acraeinae* which are often so abundant in the Andean regions may almost be said to be conspicuous by their absence, the only two species both being rare. The true *Nymphalinae* with 98 species are less abundant both in species and individuals than is the case in the mountainous parts of the continent. The *Erycinidae* with nearly 190 species are as strongly represented as anywhere else in the world, this family having its headquarters in Guiana and the lower Amazon, but they are far from being such a prominent element in the fauna that a mere catalogue would seem to suggest, many species being both rare and inconspicuous.

The *Papilionidae* have 27 species, the same number as is known from the whole of the lower Amazon, but the *Pieridae* with 29 species are more poorly represented than in almost any other South American district of equal extent although the number of "whites" and "yellows" nearly always to be seen along the banks of the rivers would give a contrary impression. The smaller *Lycaenidae* and *Hesperidae* have not yet been sufficiently collected to give any just idea of their numbers and it is in these two families and in the *Erycinidae* that the greatest number of additions to our list is to be expected.

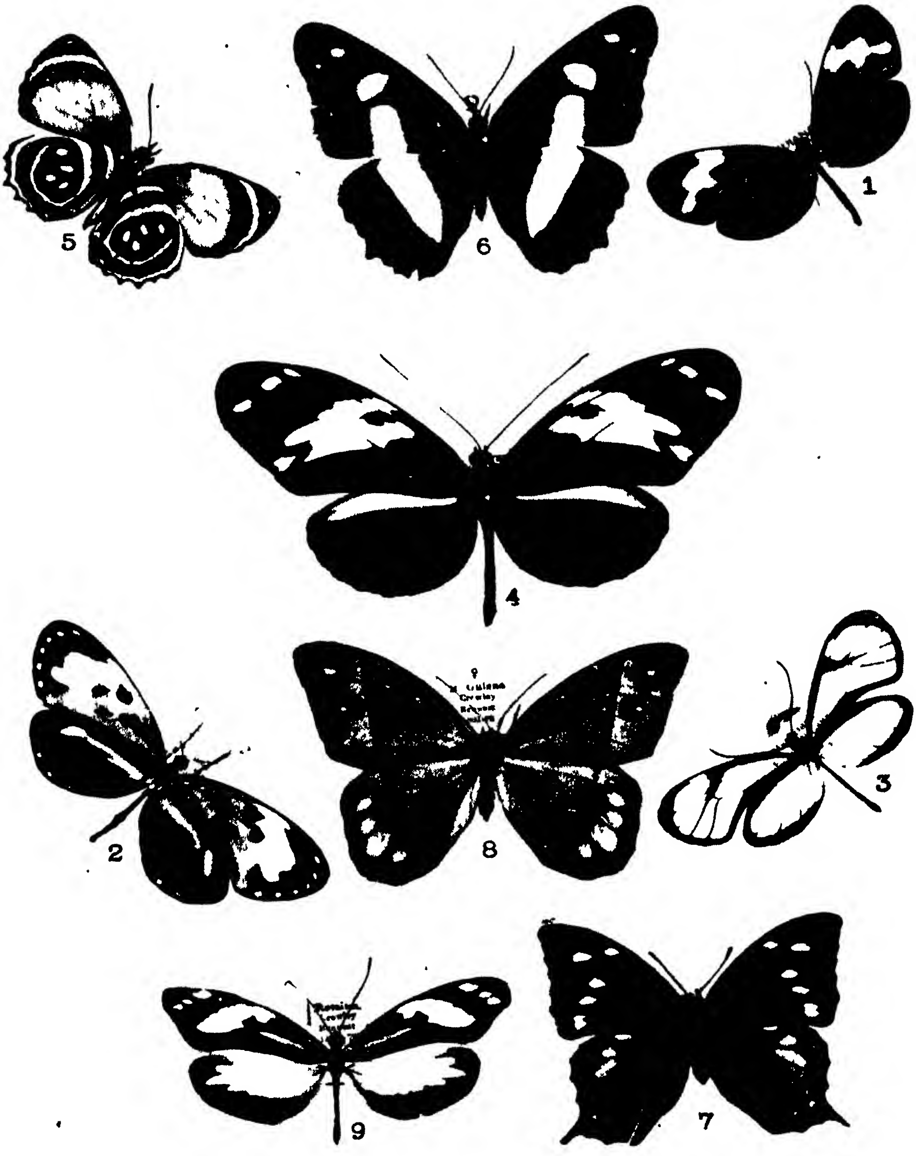

Fig. 1.—*Napeogenes hygia* Godm. Female.
Fig. 2.—*Ceratinia mutilla connera* subsp. nov. Female (Type).
Fig. 3.—*Pseudoscada urana* Hall. Male (Type).
Fig. 4.—*Heliconius hecale clearei* Hall. Male.
Fig. 5.—*Catagramma idas* *Mull.* Female Underside.
Fig. 6.—*Pyrrhogyra stratonicus* Fruhst. Female.
Fig. 7.—*Anaea pithyusa morena* Hall. Female.
Fig. 8.—*Antirrhaea taygetina rodwayi* subsp. nov. Female (Type).
Fig. 9.—*Dismorphia crisia roraimae* subsp. nov (Type).
(All figures slightly reduced).

The records in the present Catalogue are taken chiefly from the following collections, all of which have been carefully examined :

(i) The British Museum (Natural History). This includes the large collections made by H. Whitely on the Mazaruni, at Annai on the Essequibo, at Takutu, Quonga, and on the Carimang or Karanang River (the former is the spelling on the labels and is therefore here adopted), and at other places on his journey to Mount Roraima ; by W. Schaus at Omai and on the Essequibo ; by G. Rodway and others on the Demerara River ; by H. Patoir on the Berbice and many other specimens received from various collectors. With regard to these British Museum localities it may be well to note that the species labelled " Mt. Roraima " are practically all lowland forms and were evidently not collected at any great elevation. We have not been able to locate Quonga which was presumably some now abandoned settlement near the Upper Mazaruni or its tributary the Carimang River.

(ii) The Georgetown Museum. This contains a fairly representative collection of the butterflies of the country ; unfortunately the specimens have no exact locality labels but the majority are said to have come from the Demerara River.

(iii) Collections made by W. J. Kaye and his collector H. Roberts, chiefly at Tumatumari and on the old Potaro Road.

(iv) Specimens collected by myself at Parika at the mouth of the Essequibo and at Bartica and Mabaruma (N. W. District) in December 1929 and January 1930 and again at Parika, Bartica and the Kaieteur Falls in February and March 1936.

(v) The collection of the Entomological Division of the Department of Agriculture, British Guiana.

A small but very interesting collection made by G. A. Hudson on the Upper Kutari River and Upper Corentyne near the Brazil-Surinam frontier has quite recently come to the British Museum and still later a few specimens obtained by Major Beddington near the Oronoque-New River confluence in the same region, but with these exceptions records from the eastern part of the Colony, the Rupununi Savannahs and the mountains of the S. W. frontier are very scant and more information about the species found there would be very welcome.

Lastly, I have come across a paper by Dr. Roger Verity of Florence in the Mem. Soc. Ent. Italiana for 1934 on the butterflies collected by the Beccari Expedition and several species only recorded from this source are here included in the addenda.

I have particularly to thank Messrs. N. D. Riley of the British Museum (Natural History), L. D. Cleare of the Department of Agriculture, Georgetown, and W. J. Kaye, F.R.E.S., for their assistance in compiling the present Catalogue. A special debt of gratitude is also due to Professor J. S. Dash, Director of Agriculture, for kindly consenting to publish it in The *Agricultural Journal*.

Family DANAIDAE.

Sub-family DANAINAE.

1. DANAIS ARCHIPPUS.
Papilio archippus, Fab., Ent. Syst., III, (i), p.49 (1793).
Generally common. Larva conspicuous on Asclepias.

2. DANAIS ERESIMUS.
Papilio eresimus, Cramer, Pap. Exot. II, t. 175, G.H. (1779).
Annai. Apparently scarce and local.

3. LYCOREA PASINUNTIA.
Papilio pasinuntia, Cram., Pap. Exot. IV, t. 316, A.—C. (1782).
Omai ; Annai ; Mabaruma ; Potaro Road. Sometimes common.

4. LYCOREA CERES.
Papilio ceres, Cram., Pap. Exot. I, t. 90 A. (1779).
Annai ; Quonga ; Mabaruma ; Potaro Road. Locally common and very variable. The tendency for the marginal and median bands of the hind wings to unite so as to form a broad black outer patch is characteristic of the Guiana forms of the mimetic group of which this species is probably the primary model, the other members of the association being *Hirsutis harmonia*, *Melinaea mneme*, *M. crameri*, *Mechanitis polymnia*, *M. pannifera*, the three species of *Ceratinia* and *Heliconius numata*.

Sub-family—ITHOMIINAE.

5. THYRIDIA CONFUSA.
Methona confusa, Butler, Cist. Ent. I, p. 151 (1873).
Annai ; Potaro River ; Kuturi River (G. A. Hudson).

6. HIRSUTIS HARMONIA.
Papilio harmonia, Cramer, Pap. Exot. II, t. 190, D (1779).
Annai ; Kuturi River. Always scarce and local.

7. MELINAEA MNEME.
Papilio mneme, Linnaeus, Syst. Nat. I, (2), p. 756 (1767).
Generally common in forests.

8. MELINAEA MEDIATRIX.
M. mediatrix, Weymer, Stett. Ent. Zeit. LI, p. 282.
Common with the foregoing and sometimes even more abundant. A frequent aberration is *mauensis* Weym. in which the hind wings have two separate bands.

9. MELINAEA MNASIAS TECTA.
M. mnasias tecta, Haensch in Seitz, Gross-Schmetterlinge V, p. 124 (1909).
Described from British Guiana. Mr. W. J. Kaye has a specimen from the Potaro Road.

10. MELINAEA EGINA.

Papilio egina, Cramer, Pap. Exot. II, t. 191 D (1779).

Annai; Omai; Carimang River; Potaro River; Upper Corentyne.

11. MECHANITIS POLYMNIA.

Papilio polymnia, Linn., Mus. Ulr. p. 224 (1764).

Abundant in most wooded places.

12. MECHANITIS PANNIFERA.

M. pannifera, Butler, Cist. Ent. II, p. 150

Rather more local than *M. polymnia* but often abundant. Annai; Omai; Takutu; Mabaruma; Kaieteur Falls.

13. APROTOPOS PSIDII.

Papilio psidii Linn., Mus. Ulr. p. 228 (1764)

Potaro River (W. J. Kaye); Kuturi River (G. A. Hudson).

14. CALLITHOMIA ALEXIRRHOE.

C. alexirrhoe, Bates, Trans. Linn. Soc. XXIII, p. 522 (1862).

A series labelled "British Guiana, Parish" in the British Museum.

15. CERATINIA MUTILLA

Ithomia mutilla, Hewitson, Ex. Butt. IV, Ithomia t. 25 f. 153 (1867).

Demerara River; Carimang River; Bartica; Mabaruma. In the British Museum there are three pairs from Mt. Roraima which represent a local race having the two black bands of the hind wings completely fused together so as to form a single patch. I propose to call this form *connexa* form. nov. (Plate VIII, Fig. 2, female).

16. CERATINIA PELLUCIDA.

C. pellucida, Haensch, Berl. Ent. Zeit, L, p. 154.

Common at the Kaieteur Falls. In the British Museum from Annai and a slightly different form from Omai.

17. CERATINIA BARII.

C. barii, Bates, Trans. Linn. Soc. XXIII, p. 524 (1862).

Demerara River; Omai; Quonga; Annai; Takutu; Mt. Roraima.

18. CERATINIA GLYCON.

Napeogenes glycon, Godman, Ann. Mag. Nat. Hist. 1889, (3), p. 157.

Annai; Carimang River; Takutu; Potaro River; Kaieteur Falls. Common where found.

19. NAPEOGENES CYRIANASSA.

Sais cyrianassa, Doubleday & Hewitson, Gen. Diurn. Lep. t. 18. f. 1 (1847).

Represented in British Guiana by two forms, *adulta* Haensch and *dilutata* Haensch; the former is in the British Museum from Bartica, the Carimang River and Essequibo; the latter from "British Guiana"

20. NAPEOGENES HYGIA. (Plate VIII, Fig. 1, female).

N. hygia, Godman, Ann. Mag. Nat. Hist. 1899, (3), p. 157.

A single specimen was taken on the Upper Kuturi River by G. A. Hudson; the only example previously known was the type from Paramaribo.

21. NAPEOGENES POTARONUS.

N. potaronus, Kaye, Ent. Rec. XVII, p. 120.

Potaro River (W. J. Kaye); Kaieteur Falls (A. Hall.) Very rare.

22. NAPEOGENES INACHIA MOLES.

N. moles, Haensch, Berl. Ent. Zeit. L, p. 157, t. 4, f. 10 (1905).

Potaro Road; also in the British Museum from "British Guiana."

23. SAIS ROSALIA.

Papilio rosalia, Cramer, Pap. Ex. III, t. 246, B. (1782).

Omai; Demerara River; Berbice; Kuturi River.

24. SAIS PARAENSIS CAMARIENSIS.

S. camariensis, Haensch, Berl. Ent. Zeit. L, p. 162, t. 4, f. 12 (1905).

Described from Camaria on the Cuyuni. There are specimens in the British Museum labelled "Georgetown".

25. SCADA THEAPHIA.

Oleria theaphia, Bates, Trans. Linn. Soc. XXIII, p. 529 (1862).

Annai; Quonga; Carimang River; Potaro Road; Kaieteur Falls. Specimens from the Potaro Road were described as *majuscula* Haensch, but I am unable to see that they differ from the typical form.

26. DIRCENNA LENEA.

Papilio lenea, Cramer, Pap. Ex. III, t. 231, D. (1782).

Omai; Annai; Takutu; Mabaruma; Mt. Roraima; Kuturi River. At Mabaruma I took typical specimens in company with a very pale form which has been described as *drogheda* Weeks.

27. CALLOLERIA NISE.

Papilio nise, Cramer, Pap. Ex. III, t. 231, E. (1782).

Annai; Omai; Carimang River; Demerara River; Mabaruma. Locally abundant.

28. CALLOLERIA CAYANA.

C. cayana, Salvin, Ann. Mag. Nat. Hist. (4), IV, p. 167.

Potaro River; Kaieteur Falls. Rare.

29. EPISCADA SYLPHA.

E. sylpha, Haensch, Berl. Ent. Zeit. L, p. 171 (1905).

A single specimen from Quonga in the British Museum differs somewhat from typical Venezuelan examples and may represent a new race.

30. LEUCOTHYRIS AEGLE.

Papilio aegle, Fabricius, Gen. Ins. p. 255 (1777).

Bartica: Carimang River; Potaro River; Kaieteur Falls.

31. LEUCOTHYRIS ZAREPHA.

Ithomia zarepha, Hewitson, Ex. Butl. IV, Ithomia t. 27, f. 173 (1869).

Demerara River; Essequibo River: Carimang River; Bartica; Kaieteur Falls.

32. **Leucothyris astrea.**

Papilio astrea, Cramer, Pap. Ex. I, t. 22, D. (1775).

Annai; Carimang River; Quonga; Mabaruma. Generally found singly and therefore rare.

33. **Aeria eurimedia.**

Papilio eurimedia, Cramer, Pap. Ex. II, t. 126, C.D. (1779).

Carimang River; Takutu; Kaieteur Falls; Lower Essequibo River; Mabaruma.

34. **Pseudoscada florula exornata.**

P. florula ab *exornata*, Haensch, Berl. Ent. Zeit. L, p. 177 (1905), Potaro Road. A rare species.

35. **Pseudoscada wana.** (Plate VIII, Fig. 3 male).

P. wana, Hall, "Entomologist" 1930, p. 278.

Only known from Mabaruma where I took the types in December 1929.

Family SATYRIDAE.

36. **Callitaera philis.**

Papilio philis, Cramer, Pap. Ex. IV, t. 387, E. (1782).

Demerara River; Bartica; Carimang River; Mt. Roraima. A rare and beautiful species, always found singly.

37. **Haetera piera.**

Papilio piera, Linnaeus, Mus. Ulr. p. 220 (1764).

Demerara River; Bartica; Parika; Carimang River; Mabaruma; Kaieteur Falls. Not rare in heavy forest.

38. **Pierella astyoche.**

Hetaera astyoche, Erichson, Schomb. Reisen III, p. 599 (1848).

Mabaruma; Carimang River; Lower Essequibo River.

39. **Pierella lena.**

Papilio lena, Linnaeus, Syst. Nat. I, (2), p. 784 (1767).

Demerara River; Bartica; Carimang River; Mt. Roraima. Not very common anywhere.

40. **Pierella dracontis.**

Pieris dracontis, Hübner, Verz. Bek. Schmett. p. 53, n. 500 (1816).

Common in most wooded places.

41. **Pierella lamia.**

Papilio lamia, Sulzer, Gesch. Ins. t. 18, f. 1. (1776)

Demerara River; Berbice; Omai; Carimang River; Kaieteur Falls; Mt. Roraima. Common where found.

42. **Antirrhaea philoctetes.**

Papilio philoctetes, Linnaeus, Mus. Ulr. p. 219 (1764).

Demerara River; Berbice; Bartica; Parika; Mt. Roraima. Rather scarce and difficult to catch owing to its habit of flying close to the ground in the dense undergrowth.

43. ANTIRRHAEA ORNATA.

A. ornata, Butler, Ann. Mag. Nat. Hist. (4) V. p. 362.

A single specimen from Quonga in the British Museum.

44. ANTIRRHAEA TAYGETINA RODWAYI. (Plate VIII, Fig. 8 female).

A. taygetina rodwayi, subsp. nov.

Description.—Differs from typical *A. taygetina* Butl. in both sexes having the postdiscal spots of the hind wings very large and bright blue, 4 to 7 millimetres in diameter and in the rufous scaling on the outer part of the fore-wings being less pronounced.

Described from two pairs from Annai and two pairs from "British Guiana," all in the British Museum.

45. CAEROIS CHORINAEUS.

Papilio chorinaeus, Fabricius, Syst. Ent. p. 484, n. 182 (1775).

I have taken this fine species at Parika and it is reported from the Demerara River, but it seems to be very rare.

46. TAYGETIS MERMERIA.

Papilio mermeria, Cramer, Pap Ex. I, t. 96, B. (1779).

A series from Takutu in the British Museum.

47. TAYGETIS LARUA.

T. larua, Felder, Reise Nov. Lep. III, p. 466, n. 790 (1867).

Takutu; Mt. Roraima. Not a common species.

48. TAYGETIS VIRGILIA.

Papilio virgilia, Cramer, Pap. Ex. I, t. 96, C. (1779).

Not uncommon in shady places.

49. TAYGETIS CELIA.

Papilio celia, Cramer, Pap. Ex. III, t. 242, C. (1782).

There are single specimens from Demerara and Mt. Roraima in the British Museum.

50. TAYGETIS ANDROMEDA.

Papilio andromeda, Cramer, Pap. Ex. I, t. 96, A. (1779).

The commonest species of the genus and, like its allies, fond of the shady paths in the forest.

51. TAYGETIS XENANA.

T. xenana, Butler, Lep. Ex. I, t. 7, f. 3 (1870).

Annai; Bartica; Kaieteur Falls. This very dusky species is easily overlooked on account of its resemblance to *T. andromeda*.

52. TAYGETIS ECHO.

Papilio echo, Cramer, Pap. Ex. I, t. 57, C.D. (1779).

Demerara River; Annai; Takutu.

53. TAYGETIS PENELEA.

Papilio penelea, Cramer, Pap. Ex. II, t. 101, G. (1779).

The only specimens I have seen are merely labelled "British Guiana." It is a very common species in Trinidad.

54. TAYGETIS VALENTINA.

Papilio valentina, Cramer, Pap. Ex. III, t. 242, A, (1782).

Four males from Berbice in the British Museum. It is one of the rarer species.

55. EUPTYCHIA HESIONE.

Papilio hesione, Sulzer, Geoch. Ins. p. 144, t. 17, f. 3, 4 (1776).

Generally distributed and very common.

56. EUPTYCHIA BINOCULA.

E. binocula, Butler, Lep. Ex. I, t. 4, f. 5 (1869).

Found in company with the foregoing but much more local. Bartica; Parika; Quonga; Carimang River.

57. EUPTYCHIA OCYPETE.

Papilio ocypete, Fabricius, Gen. Ins. p. 260, (1777).

Omai; Annai.

58. EUPTYCHIA LYDIA.

Papilio lydia, Cramer, Pap. Ex. II, t. 148, C.D. (1779).

Demerara River; Annai; Carimang River; Kaieteur Falls; Mt. Roraima; Parika. This species is not very abundant anywhere.

59. EUPTYCHIA PICEA.

E. picea, Butler, Proc. Zool. Soc. 1866, p. 481, t. 12, f. 6 (1867)

Demerara River; Carimang River; Bartica; Kaieteur Falls. At the latter locality I took a remarkable aberration in which the red stripes appear on the upperside.

60. EUPTYCHIA MYNCEA.

Papilio myncea, Cramer, Pap. Ex. IV, t. 293, C. (1782).

Very common and generally distributed.

61. EUPTYCHIA PENELOPE.

Papilio penelope. Fabricius, Syst. Ent. p. 493, n. 217 (1775).

Another very common species, perhaps more abundant than the preceding.

62. EUPTYCHIA TERRESTRIS.

E. terrestris, Butler, Proc. Zool. Soc. 1866, p. 462, t. 39 f. 1.

Widely distributed but less abundant than the two foregoing.

63. EUPTYCHIA BATESII.

E. batesii, Butler, Proc. Zool. Soc. 1866, p. 493, t. 40, f. 16.

Demerara River; Carimang River; Omai; Kaieteur Falls. A rare species only found singly.

64. EUPTYCHIA RENATA.

Papilio renata, Cramer, Pap. Ex. IV, t. 326, A. (1782).

Common in many localities. Demerara River; Omai; Parika; Carimang River.

65. EUPTYCHIA MODESTA.

E. modesta, Butler, Proc. Zool. Soc. 1866, p. 472, n. 42.

Parika; Bartica; Carimang River; Not rare but easily overlooked on account of its resemblance to *E. renata*.

66. EUPTYCHIA HERMES.

Papilio hermes, Fabricius, Syst. Ent. p. 487, n. 195 (1775).

Probably the commonest butterfly throughout Tropical America. Abundant everywhere and at all seasons.

67. EUPTYCHIA ARGANTE.

Papilio argante, Cramer, Pap. Ex. III, t. 204, C.D. (1782).

In the British Museum from Demerara.

68. EUPTYCHIA LIBYE.

Papilio libye, Linnaeus, Syst. Nat. I, (2). p. 772, n. 146 (1767).

Common in forests and undergrowth.

69. EUPTYCHIA GULNARE.

E. gulnare, Butler, Ent. Mo. Mag. VI, p. 250 t. 1, f. 3 (1870).

A male from "British Guiana" in the British Museum.

70. EUPTYCHIA ERICTHO.

E. erictho, Butler, Proc. Zool. Soc. 1866, p. 501, t. 40, f. 12.

Carimang River: Kaieteur Falls; Mt. Roraima. Common where it occurs.

71. EUPTYCHIA TRICOLOR.

E. tricolor, Hewitson, Ann. Mag. Nat. Hist. (2), VI, p. 440 (1840).

There is a specimen of this rare and beautiful species from the Potaro River (H. Roberts) in the collection of W. J. Kaye and one from Demerara in the British Museum. Oronoque-New River Confluence (G. A. Hudson). R. Supenaam (coll. Ent. Div. G. Brinsley).

72. EUPTYCHIA LEA.

Papilio lea, Cramer, Pap. Ex. II, t. 151, C.D. (1779).

Berbice: Annai.

73. EUPTYCHIA CEPHUS.

Papilio cephus, Fabricius, Syst. Ent. p. 528, n. 359 (1779).

In the Georgetown Museum and in the British Museum from Demerara. Fond of dense undergrowth.

74. EUPTYCHIA ARNAEA.

Papilio arnaea, Fabricius, Gen. Ins. p. 260 (1777).

A common species in forests.

75. EUPTYCHIA CHLORIS.

Papilio chloris, Cramer, Pap. Ex. IV, t. 293, A. B. (1782).

Bartica: Annai; Carimang River. This species and the next are generally found together but are never common.

76. EUPTYCHIA HERSE.

Papilio herse, Cramer, Pap. Ex. I, t. 10, C.D. (1775).

Bartica; Carimang River; Annai; Omai.

77. EUPTYCHIA TOLUMNIA.

Papilio tolumnia, Cramer, Pap. Ex. II, t. 130. F.G. (1779).

Single specimens from Berbice and "British Guiana," in the British Museum.

78. EUPTYCHIA HEWITSONII.

E. Hewitsonii, Butler, Proc. Zool. Soc. 1866, p. 491. t. 40, f. 4.

Bartica; Annai; Carimang River; Quonga. This curious little species is always found singly.

79. EUPTYCHIA CLUENA.

Papilio cluena, Drury, Ill. Ex. Ent. III, t. 7, f. 5, 6 (1782).

A pair from Mt. Roraima in the British Museum.

80. BIA ACTORION.

Papilio actorion, Linnaeus, Syst. Nat. I, (2), p. 794, n. 262, (1767).

Generally distributed in dense undergrowth.

Family BRASSOLIDAE.

81. BRASSOLIS SOPHORAE.

Papilio sophorae, Linnaeus, Syst. Nat. X, p. 471, n. 83 (1758).

Common round Georgetown and in most of the coastal districts. The larva feeds upon Cabbage Palm and Coconut, clusters of the pupae often being found in the spathes. The larvae are much infested by dipterous parasites and when they escape these, the freshly emerged butterflies often fall to the ground before the wings are fully expanded and so fall victims to ants.

82. DYNASTOR DARIUS.

Papilio darius, Fabricius, Syst. Ent. p. 482, n. 173 (1775).

A specimen flew into the rest house at Mabaruma during my stay there but evaded capture.

83. OPSIPHANES CASSIAE.

Papilio cassiae, Linnaeus, Mus. Ulr. p. 265 (1764).

A single specimen from Demerara in the British Museum.

84. OPSIPHANES QUITERIA.

Papilio quiteria, Cramer, Pap. Ex. IV, t. 313, A—D. (1782).

In the British Museum from Mt. Roraima.

85. OPSIPHANES INVIRAE.

Potamis superba invirae, Hübner, Samml. Ex. Schmett. t. 76, f. 1, 2 (1806–16).

Demerara; Berbice; Mt. Roraima. Probably common in most forest regions.

86. OPSIPHANES CASSINA MERIANAE.

O. cassina merianae, Stichel, Berl. Ent. Zeit. XLVI. p. 518 (1901).

Two females from Demerara in the British Museum.

87. CATOBLEPIA XANTHUS.

Papilio xanthus, Linnaeus, Mus. Ulr. p. 276 (1764).

Demerara River: Bartica. Rare.

88. CATOBLEPIA BERECYNTHIA.

Papilio berecynthia, Cramer, Pap. Ex. II, t. 184, B.C. (1779).

Parika; Bartica; Carimang River; Mt. Roraima.

89. ERYPHANIS POLYXENA.
Papilio polyxena, Meerburg, Afb. Zeldz. Gen. t. 41 (1775).
Demerara River ; Takutu ; Mt. Roraima.

90. CALIGO TEUCER.
Papilio teucer, Linnaeus, Mus. Ulr. p. 212 (1764).
Not uncommon in many places, usually at the edges of cocoa plantations. Parika ; Demerara River ; Berbice.

91. CALIGO ILIONEUS.
Papilio ilioneus, Cramer, Pap. Ex. I, t. 52, A. (1779).
The commonest species of the genus and very generally distributed, the larva feeding upon sugar cane.

92. CALIGO EURILOCHUS.
Papilio eurilochus, Cramer, Pap. Ex. I, t. 33, A., A. 34, A. (1775).
Demerara River ; Friendship on the Berbice ; Takutu.

93. CALIGO IDOMENEUS.
Papilio idomeneus, Linnaeus, Mus. Ulr. p. 243 (1764).
Demerara River ; Berbice ; Carimang River ; Kaieteur Falls.

94. CALIGO OÏLEUS.
Pavonia oileus, Felder, Wien. Ent. Mon. V, p. 111, n. 106 (1861).
Marudi Mts., Rupununi District, (L.H.J. Ashburner).

95. CALIGO SUZANNA.
Pavonia suzanna, Deyrolle, Rev. Zool. 1872, p. 275, II. 24, 26.
There are specimens of this rare species in the Georgetown Museum and one from "British Guiana" in the British Museum. Demerara (Verity).

Family MORPHIDAE.

96. MORPHO PERSEUS.
Papilio perseus, Cramer, Pap. Ex. I, t. 71, A.B. (1779).
(a). *Papilio metellus*. Cramer, Pap. Ex. III, 218, A.B. (1782).
This fine species occurs in two forms both of which are equally scarce. In *metellus* the colour above is golden yellow whilst in *perseus* it is light blue. There are specimens of both forms in the Georgetown Museum and in the British Museum from Demerara, and the latter institution also has an intermediate specimen from the same district. Mackenzie (Verity).

97. MORPHO HECUBA.
Papilio hecuba, Linnaeus, Mant. Plant. p. 531 (1771).
This is the largest of all South American butterflies and owing to its lofty flight it is very rarely captured. I have seen the species flying high above the tree tops at the foot of the Kaieteur Falls and along the Potaro Road and there are specimens in the Georgetown Museum and in the British Museum from Demerara. Mackenzie (Verity).

98. MORPHO ACHILLES.

Papilio achilles, Linnaeus, Mus. Ulr. p. 211 (1764).

The commonest species of the genus. It is found in most wooded places and as its flight is lower and slower than most of the other species it is the one most often noticed. It is fond of settling on decaying fruits on the ground and will also come to sugar.

99. MORPHO DEIDAMIA.

Leonte deidamia, Hübner, Verz. Bek. Schmett. p. 52, n. 487 (1816).

Several at Mabaruma (A. Hall).

100. MORPHO ADONIS.

Papilio adonis, Cramer, Pap. Ex. I, t. 61, A.B. (1779).

Mr. W. J. Kaye has specimens from the Potaro River.

101. MORPHO RHETENOR.

Papilio rhetenor, Cramer, Pap. Ex. I. t. 15, A.B. (1775).

The most brilliant of all species on the wing. It occurs rarely on the Demerara River and I saw one specimen at the foot of the Kaieteur Falls in March.

102. MORPHO MENELAUS.

Papilio menelaus, Linnaeus, Mus. Ulr. p. 200 (1764).

Next to *M. achilles*, this is the most widely distributed species of the genus and is often common where it occurs, as at Bartica, Mabaruma, on the Potaro Road and elsewhere.

Family NYMPHALIDAE.

Sub-family—ACRAEINAE.

103. ACTINOTE THALIA.

Papilio thalia, Linnaeus, Mus. Ulr. p 230 (1764).

Demerara River; Berbice; Takutu. Apparently not very common where it is found.

104. ACTINOTE ANTEAS.

Acraea anteas, Doubleday & Hewitson, Gen. Diurn. Lep. t. 18, f. 5 (1848).

A. anteas f. *ochrotaeniata*, Jordan, in Seitz, Gross.-Schmett. V, p. 369 (1913).

There are two pairs of the dimorphic form *ochrotaeniata* from Mt. Roraima in the British Museum.

Sub-family—HELICONIINEA.

Before dealing with the forms of this interesting group it is necessary to remark that many species of *Heliconius*, particularly *H. melpomene*, *H. doris* and *H. erato* are highly polymorphic and have developed a number of forms which have at first sight all the aspect of different species, whilst in other cases the influence of mimicry has produced forms of different species which have a great similarity to one another and are sometimes difficult to distinguish.

Much has been written on this subject by Messrs. Charles Oberthür, W. J. Kaye, H. Eltringham, H. Riffarth, A Seitz and others but unfortunately no two authors are quite in agreement in their conclusions. In British Guiana the species are far more constant than is the case in Surinam or French Guiana but there are nevertheless a number of interesting varieties whose exact relationship can only be eventually proved by breeding. I therefore express no opinion as to how far the forms here recorded are specifically distinct.

105. HELICONIUS NUMATA.

Papilio numata, Cramer, Pap. Ex. IV, t. 297, C.D. (1782).

A common species in most inland districts but apparently not found close to the sea. Lower Essequibo River (Bartica-Supenaam Forest Survey. In Coll. Ent. Div.) *Ab. melanops* Weymer is a common form in which the two black bands of the hind wings are confluent. Other aberrations have been named *guiensis* Riffarth and *mavors* Weymer.

106. HELICONIUS GRADATUS THIELEI.

H. gradatus thielei, Riffarth, Berl. Ent. Zeit. XLV, p. 195 (1900).

Several specimens from Berbice and Demerara and two taken by myself at Bartica have been placed under this name in the British Museum. It looks very much like a further aberration of *numata*.

107. HELICONIUS EUCOMA.

Eueides eucoma, Hübner, Zubr. Ex. Schmett. f.577, 578 (1825).

A single specimen is recorded by W. J. Kaye from the Potaro Road.

108. HELICONIUS VETUSTUS.

H. vetustus, Butler, Cist. Ent. I, p. 165, (1873).

Demerara River ; Bartica ; Berbice ; Potaro Road ; Mabaruma. Apparently always rare.

109. HELICONIUS SILVANA.

Papilio silvana, Cramer, Pap. Ex. IV, t. 364, C.D. (1782).

Demerara River ; Annai ; Potaro Road ; Kuturi River ; Rare and only found singly.

110. HELICONIUS ETHILLA SULPHUREUS.

H. sulphureus, Weymer, "Iris" VI, p. 311, t. 4, f.8 (1893).

A specimen from the Barima River in the collection of W. J. Kaye.

111. HELICONIUS HECALE.

Papilio hecale, Fabricius, Gen. Ins. p. 254 (1777).

(a) *H. hecale clearei*, Hall, "Entomologist" LXIII, p. 278 (1930).

This is one of the most striking of the butterflies which are peculiar to British Guiana and is interesting as occurring in two distinct races. Typical *hecale* is locally common near Parika and there are old specimens in the British Museum labelled "Demerara". The form *clearei* is only known from a restricted spot at Mabaruma where I discovered it in December 1929. A remarkable aberration called *fulvescens*, Lathy, is said to have come from Demerara but only the type specimen is known.

112. HELICONIUS TUMATUMARI.

H. tumatumari, Kaye, "Entomologist," 1906, p. 53.

Only known from Tumatumari where it was discovered by W. J. Kaye.

113. HELICONIUS MELPOMENE.

Papilio melpomene, Linnaeus, Mus. Ulr. p. 232 (1764).

The typical form is generally distributed and rather common. From Parika I have specimens of *ab. atrosecta* Riffarth in which the red band is partly broken up into spots and from Mt. Roraima the British Museum has four males and a female of a totally different form near to the one figured in Seitz as *eulalia* Riff. but with the yellow spots of the fore-wings larger, the males with an additional small spot between them.

114. HELICONIUS AEDE ASTYDAMIA.

H. astydamia, Erichson, Schomb. Reisen III, p. 595 (1848).

Demerara River; Bartica; Annai: Quonga; Potaro Road; Takutu. Only found singly.

115. HELICONIUS XANTHOCLES.

H. xanthocles, Bates, Trans. Linn. Soc. XXIII, p 561 (1862)

Demerara River; Omai; Quonga; Potaro Road. Like the preceding species it is always rare.

116. HELICONIUS BURNEYI HUBNERI.

H. burneyi huebneri, Staudinger, "Iris" IX, p. 312 (1896).

Demerara River; Omai; Annai; Takutu; Bartica; Mt. Roraima.

117. HELICONIUS EGERIA.

Papilio egeria, Cramer, Pap. Ex. I. t. 34, B.C. (1775).

A single specimen received by W. J. Kaye from the Potaro Road. It is always a rare species.

118. HELICONIUS DORIS.

Papilio doris, Linnaeus, Mant. Plant. p. 536 (1771).

Generally distributed but rarely common at any one place. This species is polymorphic but only two forms seem to be at present known from British Guiana, namely typical *doris* in which the hind wings have a blue band and *ab. delila* Hübn. with broad red streaks on the hind wings. Both forms occur together at Annai, Berbice and Mabaruma.

119. HELICONIUS CLYTIA FLAVESCENS.

H. clytia flavescens, Weymer, Stett. Ent. Zeit. LI, p. 292.

Parika; Bartica; Annai; Mabaruma. Typical *H. clytia* with white bands does not seem to occur in British Guiana.

120. HELICONIUS WALLACEI.

H. wallacei, Reakirt, Proc. Ac. Nat. Sc. Phil. 1866, p. 242.

Annai; Mabaruma. Closely related to *H. clytia* and perhaps only another form of it.

121. HELICONIUS ANTIOCHUS.

Papilio antiochus, Linnaeus, Syst. Nat. I, (2), Add. p. 1068 (1767).

Demerara River; Omai; Quonga: Bartica; Kamakusa. Often very abundant but uncertain in appearance.

122. HELICONIUS SARA RHEA.

Papilio rhea, Cramer, Pap. Ex. I, t. 54, C.D. (1775).

One of the most generally distributed species and often abundant. A form called *ab. brevimaculata* Stgr. with the band of the fore-wings broken into two spots is found at Mabaruma and probably also elsewhere.

123. HELICONIUS HYDARA VICULATA.

H. hydara viculata, Riffarth, Berl. Ent. Zeit. XLV, p.188 (1905).

The commonest of the red-banded species of *Heliconius*, especially in districts near the coast. *Ab. dryope* Riff. with a red stripe at the base of fore-wings and *ab. coralii* Butl. with the red band broken into spots are known to us from Annai.

124. HELICONIUS ERATO MAGNIFICA.

H. melpomene magnifica, Riffarth, Berl. Ent. Zeit. XLV, p.211, (1905).

Abundant in many inland districts such as Mabaruma and the Kaieteur Falls where it seems largely to replace *viculata*. The form *euryas* Riffarth from the Carimang River, Annai and Berbice hardly seems to differ.

125. EUEIDES RICINI.

Papilio ricini, Linnaeus, Mus. Ulr. p. 227, (1764).

Annai. According to Kaye the larva feeds upon Cassava as well as on Passiflora.

126. EUEIDES TALES.

Papilio tales, Cramer, Pap. Ex. I. t. 38, C.D. (1776.)

Occurs rarely at Bartica and on the Demerara River.

127. EUEIDES LAMPETO NIGROFULVA.

E. nigrofulva, Kaye, "Entomologist" 1906, p 52.

Discovered by C. B. Roberts on the Potaro River where it seems to be not uncommon locally.

128. EUEIDES VIBILIA.

Cethosia vibilia, Godart, Enc. Meth. IX, p. 245, n.6 (1819).

Potaro Road. Rare.

129. EUEIDES ISABELLA.

Papilio isabella, Cramer, Pap. Ex. IV, t. 350, C.D. (1782).

Berbice; Annai; Potaro Road. Apparently less common than in other parts of South America.

130. EUEIDES LYBIA.

Papilio lybia, Fabricius, Syst. Ent. p. 460, n. 75 (1775).

Generally distributed in wooded districts and often common.

131. EUEIDES ALIPHERA.

Cethosia aliphera, Godart, Enc. Meth. IX, p. 246, n. 7 (1919).

Very common in almost all localities.

Sub-family—NYMPHALINAE.

132. METAMORPHA DIDO.

Papilio dido, Linnaeus, Syst. Nat. I, p. 782 (1758).

A fairly common species, sometimes to be seen even in the streets of Georgetown. The larva feeds upon Passiflora, not Pineapple as stated by Madam Meriam.

133. COLAENIS JULIA.

Papilio julia, Fabricius, Syst. Ent. p. 509, n. 281 (1775).

Generally distributed and common.

134. COLAENIS PHAETUSA.

Papilio phaetusa, Linnaeus, Syst. Nat. I, p. 486, n. 123 (1758).

Locally common, chiefly in swampy districts near the coast. Not rare in the Botanical Gardens and other spots near Georgetown.

135. DIONE VANILLAE.

Papilio vanillae, Linnaeus, Syst Nat I, p. 482, n. 146 (1758).

Generally distributed and common.

136. DIONE JUNO.

Papilio juno, Cramer, Pap. Ex. III, t. 215, B.C. (1782).

Generally distributed but not so abundant as *D. vanillae*. The larva likewise lives upon Passiflora.

137. EUPTOIETA HEGESIA.

Papilio hegesia, Cramer, Pap. Ex. III, t. 209, E.F, (1782).

In the British Museum from Demerara. Apparently rarer than in most parts of South America.

138. PHYCIODES LIRIOPE.

Papilio liriope, Cramer, Pap. Ex. I, t.1, C.D. (1775).

Generally distributed and often abundant chiefly in the wet seasons. The small pale form *thymetus* Fabr. which occurs at Mabaruma and elsewhere is sometimes regarded as a different species.

139. PHYCIODES FONTUS.

P. fontus, Hall, "Entomologist" LXI, p. 11 (1928).

The type specimen, labelled "British Guiana" is the only one at present known. This came from the collection of H. Grose Smith who received most of his material from the Essequibo district.

140. PHYCIODES CLIO.

Papilio clio, Linnaeus, Syst. Nat. I, p. 167, n.52 (1758).

Generally distributed and sometimes abundant in or near forests.

141. PHYCIODES NAUPLIA.

Papilio nauplia, Linnaeus, Syst. Nat. I, p. 448 (1758).

Demerara River; Berbice; Kuturi River.

142 PHYCIODES EUNICE.

Nereis fulva eunice, Hübner, Samml. Ex. Schmett. t. 9. f.1-4 (1806—18).

Generally distributed in forests but usually only found singly. Rather common near the top of the Kaieteur Falls in March 1936.

143. PHYCIODES AVEYRONA.

Eresia aveyrona, Bates, Journ. Ent. II, p. 192 t. 10, f.4 (1861).

A single specimen in my collection from the Barima River.

144. CHLOSYNE LACINIA SAUNDERSII.

Synchloe Saundersii, Doubleday & Hewitson, Gen. Diurn. Lep. t. 24, f.2 (1847).

A specimen in the British Museum labelled "British Guiana, Parish." It is a very common species in Venezuela and in Trinidad.

(To be continued)

NEWS.

Professor J. Sydney Dash, Director of Agriculture, left the Colony for Barbados on two weeks' leave of absence on December 24, 1938, returning on January 5, 1939. During Professor Dash's absence Mr. L. D. Cleare, Entomologist, was appointed to act as Director and subsequently as Deputy Director.

Mr. C. H. B. Williams, Sugar Agronomist and Plant Breeder, returned from $5\frac{3}{10}$ months' leave of absence on January 13 and resumed duty on the same day.

As from January 1, the following Technical Assistants have been placed on the Fixed Establishment:—D. D. Blackman, N. Persaud, C. Williams, L. E. McKinnon, A. W. Sears and W. A. Bovell.

The Director of Agriculture visited Essequibo from January 10 to 13. He was accompanied by Mr. T. Bell who arrived in the Colony on December 13, 1938, to take up his new appointment as Agricultural Superintendent. Mr. Bell has assumed duty in the Essequibo District and Mr. A. A. Abraham has been transferred to the Berbice District.

A Staff Conference was held on January 19–20, when the various programmes of district work and experiments to be carried out during 1939 were discussed. On the afternoon of the 20th., the Director and Mrs. Dash were "At Home" to the senior members of the staff.

The Annual General Meeting of the British Guiana Beekeepers' Association was held on January 24.

A meeting of the Advisory Board of Agriculture was held on January 25.

A meeting of the British Guiana Poultry Association was held on January 26 and the Annual General Meeting on February 27.

Mr. E. M. Peterkin, Agricultural Superintendent, left the Colony on 28 days' sick leave on January 28, returning on February 24.

In July last year a Royal Commission was appointed "to investigate social and economic conditions in Barbados, British Guiana, British Honduras, Jamaica, the Leeward Islands, Trinidad and Tobago, and the Windward Islands, and matters connected therewith, and to make recommendations". This Commission

arrived in British Guiana on January 27, visited several districts and held public hearings from January 30 to February 23. The Director of Agriculture gave evidence on February 2.

Professor F. L. Engledow, the Agricultural Expert on the Commission, visited the Head Office and the Divisions of the Department on several occasions, and the East Demerara and Berbice Districts from February 21 to 23 with the Director of Agriculture. The Director of Agriculture also accompanied the Commission on a visit to the Essequibo Coast from February 2 to 4.

The Director of Agriculture has been appointed Chairman of a Committee "to enquire into and advise on the feasibility of establishing one or more-Dairy Products factories and to furnish estimates of the capital and recurrent expenditure of such a factory or factories". The other members of the Committee are Hons. J. I. D'Aguiar, C. R. Jacob, A. G. King, C. V. Wight, B.A., T. Lee, Dr. A. Fulton, Messrs. R. V. Evan Wong, B.Sc., and H. A. Fraser, B.V.Sc. (Acting Government Veterinary Surgeon).

Dr. D. W. Duthie, Chemist, has been attached in an advisory capacity to an International Commission appointed to investigate the possibilities of settlement of Jewish refugees in British Guiana. The members of the Commission are Dr. E. C. Ernst (Chairman), Col. H. U. Nicholas, Dr. J. A. Rosen, Mr. E. C. Bataille, Dr. A. Donovan, Sir Geoffrey Evans, Sir Crawford Douglas-Jones and Mr. D. Holdridge (Secretary).

Mr. H. Parker, General Manager of Government Rice Mills, Federated Maley States, who was detailed to investigate the possibility of the erection of a central rice mill in Essequibo, and generally to consider rice milling problems in the Colony, has submitted his report to Government. This report has been published as Legislative Council Sessional Paper No. 3/1939.

The report of the Committee appointed to report on matters connected with the establishment of a rice mill on the Essequibo Coast has been published as Legislative Council Paper No. 4/1939.

Mr. E. R. Campbell, a principal of Messrs. Curtis Campbell & Co., Ltd., visited the Head Office and the Sugar Experiment Station on March 3. Other visitors included Dr. E. C. Ernst, Dr. J. A. Rosen and Sir Geoffrey Evans, members of the Commission on Jewish settlement.

Agriculturists generally will regret that His Excellency Sir Wilfred Jackson, K.C.M.G. will be leaving the Colony shortly on medical advice. It is announced that His Excellency the Governor of Barbados, the Hon. E. J. Waddington, C.M.G., will administer the Government in the interim.

PLANT AND SEED IMPORTATION.

Introductions by the Department of Agriculture for the period November, 1938 to February, 1939.

NAME	QUANTITY.	WHENCE SUPPLIED
Economic.		
Girigiri—*Vigna ornata*	½ oz.	Agricultural Department. Zaria, Nigeria.
Tobacco Seed	5 oz.	Coker's Pedigreed Seed Co., Hartsville, S.C.
Cinnamonum zelanicum	3 oz.	Curator, Royal Botanic Gardens, Dept. of Agriculture, Trinidad.
Cucumber—3 varieties	½ oz. each	Messrs. Ferry-Morse Seed Co., California.
Pepper—California Wonder	do.	do.
Egg Plant—Black Beauty	do.	do.
Muskmelon—4 varieties	do.	do.
Watermelon—2 varieties	do.	do.
Squash—2 varieties	do.	do.
Tomato—3 varieties	do.	do.
Cane Cuttings—7 varieties	cuttings of each	Plant Quarantine Station, Dept. of Agriculture, Trinidad.
Lespedeza—5 varieties	½ oz. each	Messrs. S. H. Robertson & Son, Northumberland Co., Virginia.
Camongay—*Moringa oleifera*	¼ lb.	University of Hawaii, Honolulu, Hawaii.
Rice—4 varieties	2 oz. each	Rice Breeding Station, Karjat (Kolaba), India.
Rice—4 varieties	Samples of each	Asst. Paddy Specialist, Rice Expt. Station, Nagina, N.P., India.
Ornamental.		
Makita Nut—*Parniarium laurinum*	1 lb. 13¾ oz,	Director of Agriculture, Fiji.
Ivi Nut or Tahitian Chestnut—*Inocarpus edulis*	do.	do.
Flower Seeds	½ lb.	Messrs. Hurst & Son, London.

METEOROLOGICAL DATA, 1938.

BOTANIC GARDENS, GEORGETOWN.

1938 MONTHS	Rainfall, Inches	Number of Days of Rain: Under .10 in.	.10 in. to .50 in.	.50 in. to 1.00 in.	1.00 in. to 2.00 in.	Above 2.00 in.	Total Days	Evaporation. Inches
January	13.34	4	7	3	6	...	20	3.86
February	15.10	9	6	2	3	2	22	3.51
March	13.76	9	6	1	4	2	22	4.47
April	7.95	4	5	7	2	...	18	4.17
May	11.17	5	15	6	2	...	28	4.12
June	13.17	4	12	6	4	...	26	3.92
July	12.74	7	8	4	1	2	22	4.12
August	14.96	6	7	4	3	2	22	3.86
September	1.85	3	3	1	...	...	7	5.60
October	3.48	3	4	1	1	...	9	5.31
November	5.12	4	4	2	...	1	11	4.18
December	6.36	8	6	1	3	...	18	4.27
TOTALS	119.00	66	83	38	29	9	225	51.39

AIR TEMPERATURE AND HUMIDITY IN THE SHADE.

BOTANIC GARDENS, GEORGETOWN.

MONTHS	Air Temperature: Maximum	Minimum	Mean	Humidity Mean
January	84.1	75.6	79.8	82.5
February	83.7	86.5	80.1	85.3
March	83.5	75.7	79.6	82.9
April	84.4	76 3	80.3	82.0
May	84.9	76.2	80.5	84.8
June	84.5	75.3	79.9	84.3
July	85.1	74.9	80.0	83.6
August	86.3	75.0	80.6	83.5
September	88.2	76.8	82.5	80.0
October	88.2	76.4	82.3	78.9
November	87.3	76.9	82.1	81.4
December	85.5	75.6	80.5	82.2
Mean	85.5	75.9	80.7	82.6

WETTEST AND HOTTEST DAYS AT VARIOUS STATIONS.

Stations	Wettest Days	Rainfall, Inches	Hottest Days	Temperture in shade °F
Botanic Gardens, Georgetown	Feb. 11th	4.31	Oct. 27th	91.0
New Amsterdam, Public Gardens	May 6th	3.92	Sept. 2nd	94.0
Onderneeming Industrial School, Essequibo	March 16th	6.39	Nov. 8th, 9th, 10th	91.0
Hosororo, N.W.D.	Feb. 14th	3.40	Aug. 10th Sept. 10th	92.5

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The

Agricultural Journal of British Guiana.

June, 1939.

EDITORIAL.

SELF-SUFFICIENCY.

Few movements are affecting modern agriculture more than the world wide trend towards self-sufficiency. The arguments for and against this movement are no longer heard as often as formerly, because the concept, whether or not approved in principle, must in most cases be given effect to in practice.

An illustration of cause and effect of this self-sufficiency movement is given by the world rice trade. There has been, within the last ten years, a great increase in the production of this crop in several major importing countries which have been compelled to regulate their imports in the interest of national economy. Such development has been particularly marked in the raw material exporting countries of the far East and South America. Thus when Malayan exports of rubber and tin were high, rice imports were large; as exports of rubber and tin fell during the world depression unemployment resulted and rice imports declined. In recent years, several of the Governments of South American countries—notably Argentina, Colombia and Peru—have increased rice import duties in order to increase home production. In Brazil extensive loans to rice growers, the systematic employment of rice specialists and other large scale spending programmes, have done much to increase domestic output. Such have been some of the causes inducing self-sufficiency in rice and the results have been equally subtle and far-reaching. Those countries which previously supplied the world's markets with rice are meeting with a curtailed demand. It is clear that these countries will, in turn, have their income restricted and so must themselves resort to self-sufficiency in one direction or another. Thus the vicious circle continues and it is in this situation that British Guiana with many other countries of the world finds itself today.

When an agricultural exhibition was held in British Guiana recently it was, therefore, not surprising to observe that a focus of attention was the indication given by the exhibition in regard to the Colony's self-sufficiency development.

The exhibition was held in New Amsterdam, Berbice, on Friday and Saturday, April 21 and 22. In spite of heavy rains causing flood conditions in many areas shortly before the exhibition, an excellent collection of agricultural exhibits of all kinds were on show. His Excellency the Governor, Sir E. J. Waddington, K.C.M.G., O.B.E., put into words the view of everyone when he emphasized how surprised he was at the fine display of exhibits which he had seen in the various stands "despite the very abnormal weather conditions." Elsewhere in this Journal is given an account of the Exhibition, where it will be seen that special mention was made of what is being achieved in regard to making the Colony more self-sufficient. The Director of Agriculture said : "The general display of garden produce is worthy of mention as it shows the great interest taken in the movement towards self-sufficiency, and Berbice in the past has been rather behind in this respect. This I feel reflects credit on the growers and I am sure the advantages of the Agricultural Bias scheme are becoming apparent".

The Berbice County Exhibition was in every way a great success, as was its predecessor in Georgetown, the Jubilee Agricultural Exhibition. In British Guiana, it is still a formidable task to organize and bring to a successful conclusion projects of this type, but with each success the task is reduced. It is evident that in this Colony there is now being built up, surely, if slowly, an exhibition tradition which provides the chief urge for co-operation between the several classes and interests in the community.

An agricultural exhibition is helpful in many ways. The producer gives of his best and sees by comparison how his best can be made better; the public takes away impressions which, by attracting attention to home grown products, makes it easier for the Colony to expand its self-sufficiency programme.

BERBICE COUNTY EXHIBITION.

The Berbice County Exhibition was held in Colony House Gardens, New Amsterdam, Berbice, on Friday and Saturday, April 21 and 22, 1939. The Exhibition took place after having been postponed on three previous occasions and even on the day previous to the date finally fixed, continuous rains threatened to compel abandonment. Not only did weather on the 21st turn out to be fine but agricultural products of all kinds poured into the exhibition grounds in quantity. It was only on the morning of the day itself that the Organizing Committee realized what a great success the exhibition was. It could be seen, from early in the day, that visitors to the show who came to be entertained, remained to be impressed.

Exhibits were invited under the 12 following classes :

1. Sugar Cane (open to cane farmers) ; 2. Rice; 3. Livestock; 4. Coconuts: 5. Coffee; 6. Provision Crops; 7. Vegetable Crops; 8. Fruit; 9. Cacao; 10. Miscellaneous Crops; 11. Home Manufactures; 12. Beekeeping.

Seven stands were erected. One stand, reserved for the various Divisions of the Department, displayed exhibits of an educational nature. A special feature of this stand was the use of diagrams, models and simple means of illustration to render the propaganda efforts as effective as possible. A separate stand, faced with split sugar canes, prepared by the Sugar Experiment Station, contained educational exhibits relating to sugar production. In addition, there were three large stands to house competitors' agricultural exhibits and two for livestock entries. In certain classes so many articles were received that they had to be placed on the ground near to their respective booths. It is estimated that 5,000 persons visited the exhibition and that approximately 1,000 exhibits were on view.

In the sugar educational exhibit, several diagrams bearing on the different aspects of sugar-cane cultivation and the inter-relationship of the industry with the Colony's economic structure were on view. During the last decade the Colony's yield of sugar per acre has approximately doubled; different varieties and diagrams relating to the cultural practices which have brought this about provided the public with a good deal of useful information. The Berbice sugar estates co-operated by exhibiting clumps of cane varieties and samples of manufactured products.

In the rice section, a wide range of padi and rice samples helped to give the grower an impression of the various considerations to be borne in mind in regard to different varieties. There were also diagrams in connection with the rice breeding work showing the variety status and the progress in the establishment of pure line areas.

In the entomological section, the chief feature was a series of large posters showing in colour the different stages in the life history some of the Colony's important pests together with control measures. Specimens of the Amazon fly in a breeding cage helped to give an indication of the method that has been found effective in rearing this fly in sufficient numbers to reduce the damage caused by moth borer to the present level. Several types of spraying machines were on view.

In the horticultural and plant propagation section plants of economic value formed a special feature together with demonstrations relating to the methods to be adopted in budding and grafting. Various simple hints in regard to nursery practices were also given. A special tobacco demonstration showing the different stages in the production of the crop up to and including the curing stage appeared all the more realistic with the inclusion of a model tobacco barn. The barn was made to scale and included flues, wires for hanging and even small tobacco leaves.

The chemistry section illustrated various features of soil work, including soil-less culture of vegetables and flood fallowing, and demonstrations in connection with parboiling and rice processing.

Standardised beekeeping equipment was shown with the object of drawing the attention of rural beekeepers to the advantages obtained from modern practice and appliances.

An effort was made in the economics section to indicate by diagrams some of the chief trends in economic progress during recent times. Attention was, for example, drawn to the remarkable expansion in the exports of cattle and poultry to Trinidad within the last three years.

Leaflets especially those which would be considered of practical application to the farmer were on show and distributed to those interested.

The Department of Agriculture is indebted to the Exhibition Committee for the assistance given in connection with organization arrangements Members of the Committee were :

Members of the Advisory Board of Agriculture with

Hon. J. Eleazar, Mayor of New Amsterdam

Hon. E. A. Luckhoo, O.B.E.,

District Commissioner, Berbice,

Messrs. G. M. Eccles, H. F. Chapman, F. F. Ross, Jas. Bee, J. C. Gibson, S. J. F. Blanchard, T. P. Jaundoo, C. Farrar, H. T. King, J. Haly, Rev. A. E. Dyett, Canon Gregory and the Agricultural Superintendent, Berbice.

Thanks are also due to the Militia Band which was in attendance on both days.

The following is an account of the opening ceremony :

DIRECTOR OF AGRICULTURE'S REVIEW

Your Excellency, Your Worship, Ladies and Gentlemen :—I speak on behalf of the Berbice Exhibition Committee. My most important duty to-day—and it is a real pleasure, Sir—is to welcome warmly Your Excellency and Mrs. Waddington; I will not say to New Amsterdam as that would be stealing the Mayor's thunder and I am sure he will wish to do that himself.

As agriculturists we are glad to have you once more amongst us, and we do know that Barbados has spared you most grudgingly, in spite of the fact that Barbados frequently claims British Guiana as a daughter Colony. Feelings have been a little strained recently because we have had the impudence to claim that we could rival her in the production of that delectable table delicacy—the sweet potato. Anyhow, Sir, we hope when you return you will be able to say that the claim is abundantly justified.

Now, this Exhibition, like most others with which I have been acquainted in this Colony, has not been without its vicissitudes. Planned to take place originally in 1937 it was postponed to April, 1938, on account of labour troubles in the Colony; unfortunately prolonged excessive rains caused a further postponement to April, 1939. Then it had to be deferred for one week on account of the recent abnormal rains.

Looking back to previous records I find that April has usually been associated with Exhibitions although some have been held in the summer months. The 1935 Jubilee Exhibition which was most successful was an April Show. April is a good month because it is possible to stage practically everything grown in the Colony at this time of the year.

Coming more particularly to the display before you I think it will be admitted that it is most gratifying—the stands are laden with good things and would have been fuller still if the floods had not destroyed many ground provision areas, especially on the West Coast, Berbice, but the Committee felt that to go on postponing the Show could only have resulted in great discouragement and dissatisfaction to the majority of farmers. I must say that it is a source of great satisfaction to note the keenness and enthusiasm generally. Much of the detailed work has been carried out by my Berbice staff led by the Agricultural Superintendent, Mr. Abraham, east of the river, and Mr. Morgan, west of the river. Their labours have been justified by the results. It is hoped to run special competitions in the affected areas to aid their re-establishment.

I do not wish to detain you at any length, but I must refer to one or two special features. The general display of garden produce is worthy of mention as it shows the great interest taken in the movement towards self-sufficiency and Berbice in the past has been rather behind in this respect. This I feel reflects credit on the growers and I am sure the advantages of the Agricultural Bias scheme are becoming apparent. In this connexion I wish to mention particularly the splendid efforts of Mr. Fraser, Head-Master of Friends Scots School, who was one of the first batch of teachers turned out by the Agriculture Department. I will read you what Professor Engledow wrote in his school

log-book after seeing him at work with his boys whom he asked many questions and from whom he received satisfactory replies :

"15.2.39. I found the garden well managed. The boys had a far better understanding of the cultivation and management of the land than I have usually found in schools I have visited in the Caribbean. The teaching should be of good value in a district in which food and vegetable crops are grown."

(Sgd.) F. ENGLEDOW,
West India Royal Commission.

Mr. Fraser has been awarded the Cup presented by the Royal Bank of Canada.

I cannot refrain also from mentioning the minor crop efforts of Mr. Blanchard, Pln. Lochaber. He has been persevering for some time now with tobacco and tomatoes, and encouraging his tenants to improve their livestock. The heavy rains have dealt him a great blow but he is not discouraged and it gives me great pleasure to announce him the winner of the Cup presented by Barclays Bank for his initiative and enterprise.

While on the subject of tobacco which is receiving increased attention as a result of the recent demonstration by local cigarette factories, I would direct your attention to the educational exhibit in the Department's stand. It depicts the stages of cultivation right through to curing by heat and there is a model flue barn, the work of Mr. MacArthur, one of our subordinate staff.

I will not say much of Sugar and Rice. Progress in these industries is well known and they are fully represented on this occasion. The Sugar stand is splendid and the staff of the Experiment Station have done good work.

In connexion with Rice efforts in Berbice I am pleased to announce the award of His Excellency the Governor's prize of $10 to Mr. Ramjohn. Please do not fail to see Mr. Ramjohn's exhibits.

Another effort which is being specially rewarded is that of the Mental Asylum where very useful work is being put in on vegetable and fruit-growing. My own humble prize of 1,000 local cigarettes will be handed over to the Medical Officer in charge for distribution to the men who have supplied a number of exhibits.

The exhibits in the Livestock section, Home Manufactures and Fruit have all reached a high standard but time will not permit any detailed mention.

I hope you will devote some time to the educational exhibits put up by the Department of Agriculture. A visit to the stand will repay you.

It is customary at this stage to announce the winners of the Diploma of Merit awarded by the Department of Agriculture for exhibits of outstanding merit but the list is not yet complete and will be published later.

Finally, I desire to thank from the bottom of my heart all those who have contributed in any way to the success of the Exhibition, especially farmers and cattle-raisers who have suffered great hardship recently.

I now have much pleasure in asking Your Excellency to open the Exhibition.

H.E. THE GOVERNOR OPENS EXHIBITION

His Excellency said that he was very surprised at the fine display of exhibits which he had seen in the various stalls. He was told that about 12 years ago an exhibition was held in New Amsterdam during the *régime* of His Excellency Sir Cecil Hunter Rodwell and though that one was of a very high standard this exhibition, despite the very abnormal weather conditions he was told, was not one whit behind.

He congratulated Mr. W. A. Fraser of whom Professor Engledow had spoken so highly on having annexed the beautiful silver trophy presented by the Royal Bank of Canada for his fine display of garden produce. He also congratulated Mr. Blanchard who won the Cup presented by Messrs. Barclays Bank for his initiative and enterprise. He also thanked the Mayor and Town Council for the help they had given and also Professor Dash and his Staff for all that they had done.

The Hon. J. Eleazar, Mayor of New Amsterdam, in thanking His Excellency for coming to declare the show open, made reference to the abnormal weather conditions and the need for proper drainage for farmers. Despite the weather, however, they were able in two weeks to bring off a fine exhibition. He thanked all those who had helped to make the show a success.

Mrs. Waddington presented the Cups to the winners with whom she shook hands and whom she congratulated. She was presented with a beautiful bouquet by little Miss Cynthia Harrington.

His Excellency thereafter declared the exhibition open.

DIPLOMAS OF MERIT.

An announcement has since been made of those exhibitors who have been awarded Diplomas of Merit. The list is as follows :—

Name	*Exhibit*
Ramjohn, Corentyne	Long grain padi and rice—Demerara Creole Variety.
Rash Beharry & Co., Essequibo	Whole grain super rice packed for export—Blue Stick variety.
Rev. A. E. Dyett, Corentyne	Holstein Bull.
Harold Ramdeholl, New Amsterdam	Capons.

Auchlyne Scots School, Whim, Corentyne	School Garden Produce.
Friends Scots School, E.B., Berbice River.	School Garden Produce.
No. 5 Congregational School, W.C., Berbice	School Garden Produce.
Henry Chan, Rosignol, W.C., Berbice	Grapefruit—produce of Pln. Plegt Anchor, Berbice River.
Plantation Providence, Berbice	Limes and lime products.
Emily Collins, Golden Grove, E.C., Demerara.	An assortment of meals.
Cecilia Robinson, Enmore Front, E.C., Demerara.	An assortment of meals.
Domestic Science Centre, New Amsterdam, Berbice	An assortment of preserves.
Georgetown Prison	Fibres, Ropes and Mats.
British Guiana Broom Factory, Georgetown.	Brooms.

ORIGINAL ARTICLES.

THE AMAZON FLY (*METAGONISTYLUM MINENSE*, TOWNS.) IN BRITISH GUIANA.*

By L. D. CLEARE,

Entomologist, Department of Agriculture, British Guiana.†

CONTENTS.

1. HISTORY OF THE PROJECT.

In 1932 on an expedition in Brazil, Dr. J. G. Myers, of the Imperial Institute of Entomology, while in search for suitable parasites for introduction into this and other colonies in the West Indian area, discovered the Tachinid fly *Metagonistylum minense*, Towns., known generally now as the Amazon fly, as an important parasite of *Diatraea saccharalis*, F., in the vicinity of Santarem on the Amazon, and as the result of his investigations there, formed the opinion that it would be a suitable parasite for introduction into British Guiana.

On his return to British Guiana in January 1933, Dr. Myers acquainted the Sugar Producers' Association of this Colony of his discovery, and suggested the utilization of the parasite in the cane-fields of British Guiana. The Association undertook to bear the cost of the introduction of the parasite and provided a sum of £2,000 for this, the fund being administered by the Director of Agriculture.

In May 1933 Dr. Myers, accompanied by Mr. A. H. Pickles, Entomologist of the Sugar Investigations Committee of Trinidad, and Mr. L. C. Scaramuzza of Cuba, left Georgetown for the Amazon district by way of the hinterland of British Guiana for the purpose of making collections of the parasite for shipment to this country. The first shipment of the parasite arrived in British Guiana on 30th August, 1933.

* Reprinted from *Bullentin of Entomological Research*, Vol. 30, Part 1, April 1939.

† Seconded as Entomologist-in-charge, Sugar-cane Moth-borer Investigations, Colonial Development Fund, July 1931 to April 1935.

An account of the discovery of the fly, the return journey to Brazil and the collection and shipment of the insect from Brazil to British Guiana, has been published already by Myers (11).

The present account deals, therefore, only with such of the work as was undertaken in British Guiana either by the writer personally or directly under his control, namely, the receiving of the parasite in this country and the rearing of the flies from the initial shipments, the subsequent rearing of large numbers of flies for the colonization of the sugar-estates of the Colony, including the training of East Indian laboratory assistants for work on the sugar-estates and the supervision of the rearing work on the estates. This work extended over a period of twenty months, from September 1933 to April 1935. Since then, the writer has been closely associated with the Amazon fly situation in the Colony and during the past year (1937) was engaged on a status survey of the fly in British Guiana. In conjunction with Myers' paper the present account should form a more or less complete record of the introduction and establishment of this insect in British Guiana.

The introduction of the Amazon fly into British Guiana was the first importation of this insect into any country and its first use in biological control. Since then the Amazon fly has been introduced into the Islands of St. Lucia, Trinidad and Puerto Rico from material bred in British Guiana, and into the island of Antigua from St. Lucia. These introductions do not come strictly within the scope of this paper so will merely be touched upon in another section.

2. Introduction of the Parasite.

Shipments received.—The collection and transport of the insect to British Guiana has been dealt with fully by Myers (11) and need not be repeated here.

The first trial consignment of puparia was received in Georgetown by registered air mail (Pan-American Airways) on 30th August, 1933. Of the 57 puparia sent on that occasion, flies had emerged from 31 *en route* and the insects were already dead when the package was received, and from the remaining 26 puparia only three flies were secured and a fourth died during emergence. The air mail on this occasion was 23 hours late on its schedule in arriving at Georgetown, and this, no doubt, to some extent accounted for the high mortality of this consignment. The later consignments showed considerable improvement as regards the percentage of flies secured.

From a total of 3,000 puparia shipped from Brazil, 1,409 flies, or 46.9 per cent. were secured in British Guiana; 935 puparia (31.2 per cent.) failed to produce flies, while 592 flies (19.7 per cent.) emerged and died in transit, and 64 puparia (2.1 per cent.) produced secondary parasites; making a total of 1,591 or 53.1 per cent. "failures."

Considering the long voyage, the difficulties of transport, and the narrow margin which the pupal period of the insect allowed to accomplish it, the number of flies secured must be considered good.

Fig. 1.—The Amazon Fly, *Metagonistylum minense*, Towns. x 6.

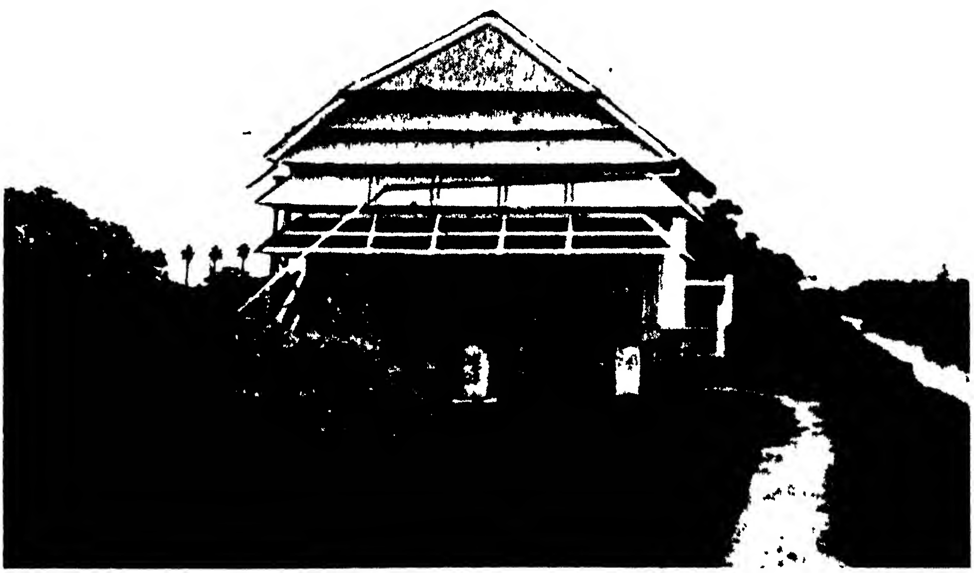

Fig. 2.—Sugar-cane Moth-borer Investigation Laboratory, 1931—35, at Sugar Experiment Station, British Guiana.

Receiving and handling the material.—The packages containing the puparia after coming down the Amazon in a special launch were posted by registered air mail at Para. The arrival of the launch at Para was made to synchronise with the departure of the Pan-American Airways plane which runs a regular weekly service between that port and Miami, Florida, U.S.A., via French, Dutch, and British Guiana and certain West Indian islands, and in this way a minimum of delay was obtained.

The time of approximate arrival of the plane at Georgetown being previously ascertained, the writer took charge of the packages personally at the General Post Office, Georgetown, as soon as the mail was received there, and conveyed them immediately to the laboratory.

The puparia in the earlier shipments were packed in damp fibre, but later when bagasse* that was sent from British Guiana was available, in that material, in 2 oz. ointment tins, the number of puparia in each tin varying somewhat according to the total number in the shipment, the maximum being about fifty in any one tin. The ointment tins were then packed in a liberal amount of cottonwool in a cardboard box and the whole wrapped.

As the journey down the Amazon from Santarem to Para occupied some six days by launch, and the plane trip from Para to Georgetown a further day and a half, and as the puparia had to be collected some days before, it was natural that there should have been a fairly high percentage of adults emerging *en route*. The majority of such flies died before the receipt of the packages and constitute 37.2 per cent. of the total failures. Some of these flies, probably those which emerged only a few hours before the actual receipt of the packages at Georgetown, were always found crawling about in the tins when they were opened and it was possible to save a number of these.

On arrival in the laboratory the packages were opened within a special glass-sided cage in order to secure any secondary parasites that might have emerged in transit, and the newly emerged flies which were found to be still alive were collected and transferred to suitable cages. The puparia were then sorted and those from which flies had emerged removed, the remainder being transferred, five at a time, to cylindrical glass lamp-chimneys of 2½ inches diameter, one end standing in damp sand and the other being plugged with cotton-wool. In these the flies subsequently emerged and were transferred thence to cages.

From the earlier consignments some of the flies were released within a day or two of emergence, and some retained for rearing trials in the laboratory.

Secondary parasitism.—In spite of the care exercised at the sending end, as was to be expected, a small number of the puparia received produced secondary parasites. Of the 3,000 puparia received in shipments, 64, or 2.1

* Sugar-cane after the juice has been extracted. With modern manufacturing methods it is reduced to a fine sawdust-like form.

per cent., produced such secondary parasites. Three secondary parasites were thus secured, namely, *Melittobia* sp. (EULOPHIDAE), *Trichopria* (*Ceratopria*) sp. (DIAPRIIDAE), and *Signophora dipterophaga*, Girault (ENCYRTIDAE), the last of which, already known as a secondary parasite of *Leskiopalpus* (*Stomatodexia*) *diadema*, Wied., in British Guiana, being predominant.

3. BIONOMICS.

The fly *Metagonistylum minense* was first described by Townsend (19) in 1927. Subsequently it was redescribed by Aldrich (1). In 1933 Monte (10) recorded it as attacking *Diatraea saccharalis*.

The only country in which the insect is known to occur naturally at present is Brazil. In that country, however, its range is considerable. First recorded from the Lower Amazon district, it has been discovered recently by Harland (9) in the vicinity of São Paulo. Harland suggests that the insect in the São Paulo area is a distinct biological race.

The adult of *Metagonistylum minense* is an insect of striking and characteristic appearance, and even in a general way is not likely to be mistaken for other flies parasitic on *Diatraea*, the large and prominent antennae, carried extended in front of the head, serving readily to distinguish it in the field.

The fly varies considerably in size, and may measure from 6.5 mm. to 10.0 mm. long, and is about 3½ to 4 times as long as it is broad. The antennae are black in colour, large and prominent, and protrude in front of the head; the front of the head is considerably produced and cone-shaped; the thorax is bluish-gray with two darker longitudinal stripes; the abdomen reddish-brown with a median darker stripe, showing bluish-gray reflections in certain lights, the last segment being much darker, and there are many strong bristles; the wings are large and strong and of a smoky brown colour, the legs are black. There is no difference in size between the sexes, but they may be usually distinguished superficially by the shape of the abdomen, the male abdomen being rather more blunt and more bristled than that of the female.

The newly emerged larvae are small, measuring only 0.6 mm., and very active. When they become fully grown they may measure from 12.1 mm. to 13.9 mm. in length.

The puparium when first formed is chestnut-brown, but becomes darker later as development proceeds; it is oval in shape, both ends being evenly rounded, and may vary from 5.4 mm. to 8.8 mm. long and from 2.2 mm. to 3.1 mm. broad depending upon the food available for the larva. It may be readily distinguished from the puparium of the other fly parasites of *Diatraea* by means of the anal spiracles.

Life-history.—Myers (12) has given a short account of the life-history and bionomics of the fly, based partly on rearings on the Amazon and partly on the work in British Guiana. During the course of the very extensive

laboratory rearings which were carried out in British Guiana the writer was able to obtain considerable data on the life-history and bionomics of the insect and these will now be given.

The total life-cycle of the insect varies from 10 to 27 days, of which 5 to 9 days are spent as a larva within the host and 7 to 9 days in the puparium. Laboratory rearings of 20,556 individuals gave a mean life-cycle of 16.77 days.

Of 20,566 flies, 6,132 (29.8 per cent.) had a total life-cycle of 16 days, in 26.8 per cent. it was 17 days; in 15.0 per cent. it was 18 days; in 13.3 per cent. it was 15 days; and in 6.3 per cent. it was 19 days. So that for 91.2 per cent. of the flies the life-cycle was between 15 and 19 days. The life-cycle varied from 10 days (0.39 per cent.=8 flies) to 27 days (0.001 per cent.=1 fly.)

The adult female deposits eggs which hatch immediately on deposition, the empty egg-shell being at times plainly visible to the naked eye, and two or three larvae are so released at a time. Deposition takes place either at the entrance of the *Diatraea* tunnel or on the cane-stalk in the vicinity of tunnels, and the young larvae may wander about considerably before finding a host, while doubtless a very large proportion never do encounter a *Diatraea* larva and consequently perish. One or more larvae may also enter a single host larva.

When fully developed the larva leaves the host, which has by that time died and putrefaction set in, and pupation occurs either within the *Diatraea* tunnel, behind a broad leaf-sheath of the cane, or the larva may fall to the ground where pupation takes place. From five to twelve days is spent in the puparium, after which the adult fly emerges.

Mating.—Mating occurs from a couple hours after the emergence of the fly from the puparium to as long as six or more days after this. It takes place with the insects in the resting position, quite often with the head downwards, but the body of the female is rather closely appressed to the surface on which she rests. The body of the male is generally in the same axis as that of the female, the forepart being raised somewhat on its forelegs and the abdomen depressed so as to make contact with the female. During coition the male sometimes makes violent convulsive and apparently excited movements as if to secure better connexion. The genitalia of the male are visible during coition.

Mating commences at times with a short struggle, but at other times takes place quietly, the male merely approaching the female and getting into position. There appears, however, usually to be a preliminary "love play" in which the male strikes the female a number of blows with his abdomen, in a hammer-like manner and apparently with some force; meanwhile the genitalia of the male are extended visibly, the female offering no resistance and apparently accepting it as a normal proceeding.

When the female is ready to accept the male she raises her abdomen and union is almost immediately effected. For a while after copulation commences the antennae of the male are held close against the front of the head but later are extended, sometimes first one and later both; the antennae of the female are extended all the time.

The time spent *in copula* is usually from ten to twenty minutes, but matings as short as two minutes and as long as seventy-seven minutes have been recorded, the average duration in 1,015 matings having been 15.98 minutes (Table I).

TABLE I.

Showing Duration of Matings of Metagonistylum minense.

Copulation in Minutes	1933			1934							Total
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	
— 5	1	—	5	—	—	—	—	—	—	—	6
—10	3	1	29	12	16	7	14	6	5	3	96
—15	5	16	46	32	39	48	57	53	53	63	412
— 20	3	6	19	22	36	29	44	28	40	43	270
— 25	—	3	3	9	13	9	14	36	26	16	129
— 30	1	1	—	3	5	6	3	10	13	8	50
—35	1	1	1	5	2	3	5	1	4	2	25
—40	—	—	1	1	1	—	4	3	1	2	13
—45	—	—	—	—	—	—	2	—	—	1	3
— 50	—	—	—	—	1	—	1	—	1	1	4
—55	—	—	—	—	—	—	—	—	—	—	—
—60	—	—	—	—	—	—	—	1	1	—	2
— 65	—	—	—	—	2	—	—	—	—	—	2
—70	—	—	—	—	—	—	—	—	1	—	1
—75	—	—	—	—	—	—	—	—	1	—	1
+	—	—	—	—	—	—	—	1	—	—	1
No. Pairs ..	14	28	104	84	115	102	144	139	146	139	1,015
Total minutes	195	421	1,226	1,288	1,873	1,541	2,321	2,491	2 600	2,252	16,208
Copulation minutes—average ...	13.9	15.0	11.8	15.3	16.3	15 1	16.2	17.9	17 8	16.2	15.98

It was observed early in the rearing work that a male would mate on more than one occasion, both with the same female and with different females. When mating occurred more than once with the same female there was either a complete separation of the flies with a loss of position of the male, or only a short interval in what could be mistaken for a continuous mating, the male remaining in position on the female during this time. Mating with different females on different days occurs also, and the data obtained in such instances showed that each female was fertilized, but there was a definite indication that the number of larvae produced gradually lessened.

Females also have been observed to mate more than once, but in every such instance these matings occurred on the same day with short intervals only, and it would appear that such matings must be regarded as incomplete matings in the first instance rather than independent matings as in the males.

The all-important factor in mating is the intensity of the light. In previous work on TACHINIDAE some stress has been laid on the size and type of cage used for the flies in order that mating may take place rapidly. When work with this insect was commenced, bearing this in mind, comparatively large cages were used, but it was soon found that mating occurred frequently in much smaller cages, and it became evident that some other factor was involved. Investigation suggested intensity of light, and further work which followed confirmed this. Later, when the correct intensity of light was ascertained, it was found possible to obtain matings at almost any time of the day and in receptacles of any size, provided that the required intensity of light was obtainable, so much so that for laboratory purposes females were usually mated in 6 × 1 inch specimen tubes.

When mating is about to take place, as soon as the required intensity of light is attained the flies become active, this activity being a peculiar restless movement which is characteristic. Should the light either increase or decrease in intensity this activity at once ceases.

At first in order to standardise conditions the intensity of light was tested by means of a photographic exposure meter of the actinometer type, for want of a better instrument. The meter used was a simple comparator type, the Watkin's Bee Meter, which gave quite satisfactory results for general purposes.

It has been possible since to carry out tests of the intensity of light at which mating occurs with a Sixtus photo-electric meter. From a series of such tests it has been found that mating occurs in lights of an intensity within the comparatively narrow limits, on this meter, of the upper portion of the 25 area (needle in line with figure 4 on lower scale) and the lower portion of the 50 scale (needle at end of 4 area on lower scale) but usually about the upper end of the 25 area. In lights of intensities of either below or above the mating range the flies are usually quiet, thus at about the lowest quarter on the 25 area

(25.1—25.2), as the lower extremity of the scale, and the highest quarter in the 50 area (50.6—50.7), as the upper extremity, mating activity ceases.

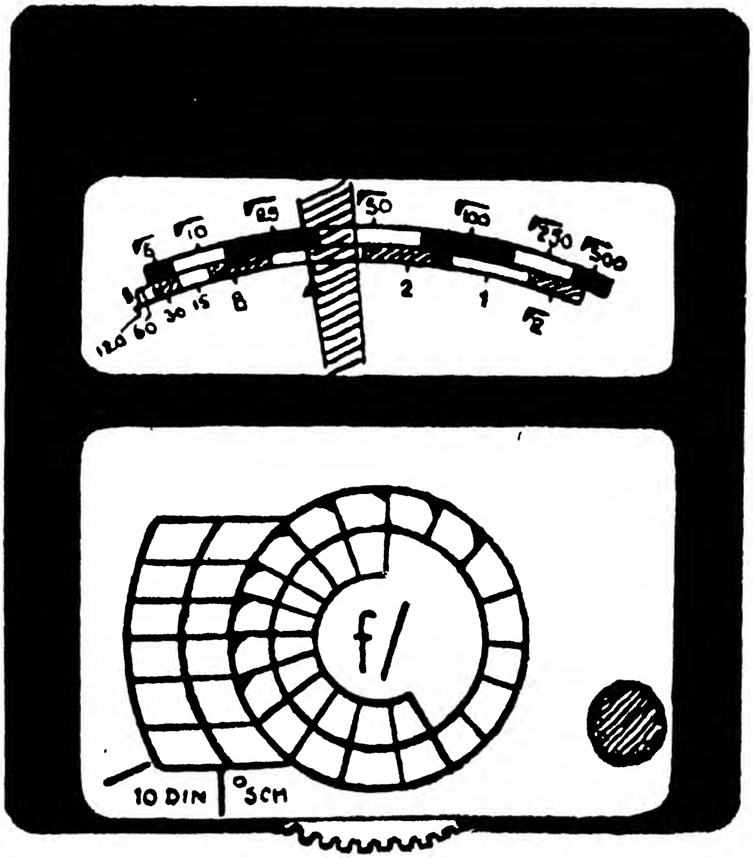

Fig. 1.—Sketch of Sixtus photo-electric exposure meter showing intensity of light (shaded area) at which matings of *Metagonistylum* occur. The details of the meter with regard to emulsion speeds and f/values are not shown as they have no bearing on the intensity of light with regard to matings of the fly.

Gestation.—About six days after fertilisation the female fly is capable of depositing eggs. It is presumed that under natural conditions the fly would commence ovipositing as soon as this was possible and that each day such ova as were sufficiently developed would be deposited. For laboratory rearing it was found better to allow the female to go a couple of days longer before dissection in order to obtain a maximum of larvae for infestations.

Reproductive capacity.—The reproductive capacity of the Amazon Fly is considerable. Dissections undertaken to determine this showed that a total of as many as 991 ova and larvae may be contained in a single female, and as few as 180 ova and larvae. The mean capacity of 100 females was 559.1 ova and

larvae, and 188.7 ova and 368.7 larvae, with an average mating time of 17.8 minutes. Table II gives the data in this connexion.

The duration of mating does not appear to have any effect on the number of ova and larvae produced by a female. The longest mating in the 100 females was of 50 minutes duration and the contents of the uterus on dissection in this instance was 310 larvae and 257 ova (total 567), while the individual with the shortest mating, of only 7 minutes duration, contained 505 larvae and 235 ova (total 740) ; in both instances the dissection was made on the seventh day after mating.

TABLE II.

Showing Reproductive Capacity of Amazon Fly.

Month		No. of flies	Minutes mating—average	Contents of uterus—average		
				Larvae	Ova	Total
1933						
December	...	16	15.9	322.1	144.2	466.3
1934						
January	...	31	19.6	421.3	145.1	566 4
February	...	26	15.7	449.3	184.4	633.7
March ...	...	11	14.7	417.8	191.5	609.3
April ...	...	15	16.1	266 9	227.2	494.1
May ...	...	1	25.0	345.0	240.0	585.0
Total	...	100	107.0	2,222.4	1,132.4	3,354.8
Mean	...	—	17.8	368.7	188.7	559.1

Number of parasites per host.—In the rearing of the parasite in the laboratory host larvae were infested with one or two larvae according to the stage of development and size, with a preference on the whole for single infestations, especially when host larvae were obtained from an area in which the fly was already established. That this method gave satisfactory results will be seen from the recovery figures of the laboratories given later.

As to the number of parasites that will develop within a host under natural conditions, examinations have shown that with *D. saccharalis* as the host from 60 to 65 per cent. of the larvae parasitized contain but a single parasite larvae, from 25 to 30 per cent. contain two parasites, 6 to 7 per cent. contain three parasites, from 1.5 to 2.5 per cent. contain four parasites, and between 0.2 and 0.3 per cent. contain five parasites. In one isolated instance in the laboratory one host larva was found to contain 7 parasite larvae.

Habits of adult.—The adult fly emerges under laboratory conditions invariably in the morning hours between 8.30 and 11 o'clock, but emergence

occasionally occurs in the afternoon also, about 1 p.m. and even as late as 5.30 p.m. The emergence of the fly appears to be dependent principally on temperature and humidity.

In the cages the adult fly will rest on cane leaves or grass placed therein for this purpose or on the mosquito-net covering, and in so doing often assumes a position head downwards, which may probably be considered their more general resting position.

In the field one does not often see the adult fly and then it is usually found resting on the underside of the cane leaves. The fly seeks this position for shelter from the sun during the heat of the day, and during rains also it has been observed to shelter thus. In the cooler periods during the morning and the evening they are to be found resting on the upper surfaces of the cane leaves and weed grasses in or near the fields.

In the cages in the laboratory the adult fly feeds readily on sugar, which was found preferable to syrup in which they usually became entangled and died as the result. White sugar (refined sugar or washed muscovado) proved preferable to yellow crystals; indeed, if fed on the latter, the mortality increased very considerably as well as the longevity being actually reduced. This high mortality with the use of yellow crystals was assumed to be due to the stannous chloride used in the process of making this grade of sugar, although it was never actually proved. Sugar of the dark crystal or muscovado grade (Java process) proved suitable for feeding also. Under field conditions feeding of the adult has not been observed.

As to the longevity of the fly nothing is known under natural conditions In the laboratory flies have been kept for as long as 21 days, but the majority survived from 10 to 12 days. Some flies died as early as the fifth or sixth day after emergence, which in females would be before the period of gestation would be completed, assuming that mating took place on the day of emergence.

Host location.—In the location of the host there can be no doubt that the fly is guided by smell. Apart from the impossibility of seeing the host located, as it is within the cane, this has been amply proved in laboratory rearings.

At the beginning of the work when little was known of the biology of the fly and the number of flies on hand was very few, it was not advisable, nor in fact would the material available allow of it, to dissect flies for rearing purposes and flies were induced to oviposit in order to obtain an approximate time when dissections might be undertaken.

It was then found that flies with ovaries sufficiently developed would readily oviposit on a glass plate if a *Diatraea* larva was squashed and smeared on the plate;

in fact while they could be induced to deposit by this method they took little notice of a living *Diatraea* larva placed on the plate.

This method proved further that there was no selection on the part of the adult as regards host, for they deposited just as readily in the presence of smears of *Diatraea canella* larvae as in those of *D. saccharalis.* That the larva of the parasite will not develop with equal facility in these hosts is another aspect that will be dealt with later.

4. Species of Diatraea attacked.

Up to the present, *Metagonistylum* has not been recorded as attacking any genus other than *Diatraea* and, according to Myers (11), it attacks two species, namely, *D. saccharalis,* which he states is the "favourite host," and from which species the bulk of the material was obtained by him in the Amazon, and "another *Diatraea* apparently a new species allied to *D. impersonatella,* the most destructive small borer in Trinidad."

Although it was known that *Metagonistylum* attacked *D. saccharalis* at the time of its introduction into British Guiana, there was no information available as to whether the parasite would attack *D. canella,* the other species commonly occurring in this country.

The small amount of material in the early consignments did not allow any trials of this nature, and accordingly at the commencement of the work flies were released in fields regardless of which species of *Diatraea* predominated.

As soon as it became possible, however, this point was investigated and a series of infestations of larvae of both *D. saccharalis* and *D. canella* were carried out. The results of these infestations showed that, while a few larva of *D. canella* may be infested artificially with the parasite, the large majority of fly larvae so used did not develop in this species. From a total of 6,523 *Diatraea* larvae artificially infested, comprising 3,503 *D. saccharalis* and 3,020 *D. canella,* the parasite recovery was 36·0 and 1·2 per cent. respectively. From that time *D. saccharalis* was used exclusively for laboratory rearings of the fly. It should be pointed out in this connexion that there is no actual difficulty in infesting *D. canella* larvae artificially, but the parasite larvae invariably fail to develop beyond the second stage, apparently owing to some physiological condition of that host.

The failure of some of the early releases of flies made in young ratoon fields in which there was a large preponderance of *D. canella* and in which recovery of the fly was not accomplished was also thus explained. Later, as the

work became better organised, when an area was being stocked with the parasite, counts were made to ascertain the density of the *Diatraea* population and the preponderant species.

More recently as the result of inquiries of sugar planters as to whether the parasite would not eventually develop a strain that would attack *D. canella* more successfully, and if this desirable condition could not be arrived at by laboratory rearing, work was undertaken in this direction.

This work has already formed the subject of a paper by the writer (5), and it will be necessary to state here only that in rearings extending over a year and comprising three separate groups of material through ten generations with a total of 6,795 *D. canella* larvae artificially infested, an average of less than 4 per cent. produced puparia. There was no significant difference between either groups of larvae or generations and therefore no indication that the parasite could be reared in numbers on this host, nor of the development of a strain of the parasite more adapted to survival in this host species.

5. Colonisation of British Guiana.

Rearing the fly in the laboratory.—In the rearing of the fly in the laboratory the method followed was that suggested by Thompson (18) and successfully employed by Scaramuzza (15) and Box (2) in the rearing of *Lixophaga*, with such modifications as appeared necessary for this particular insect. For convenience a detailed account of the technique and the apparatus used will be given.

In the first instance gravid females which are known to have mated eight days previously are anaesthetised with carbon tetrachloride. As soon as the fly is dead, the uterus with its contained larvae is removed in physiological salt solution, the uterus being then ruptured and the larvae released in the salt solution. *Diatraea* larvae, previously collected from the fields, are then infested by placing upon them, by means of a small sable-hair brush, larvae of *Metagonistylum*. The infested *Diatraea* larvae are then placed in 1 oz. ointment tins (salve tins) where they remain for some three hours and are then transferred to young cane-shoots. The cane-shoots with the contained moth-borer larvae are then stored in special tin-boxes for a period of twelve days. Puparia obtained from these tins are kept for the emergence of flies, or balloon fly-traps are attached to the tins and the flies emerging are thus secured. From these flies a number of known mated females are retained for laboratory use, and the remainder liberated in the fields after a period of from five to eight days, being kept during this time in the mating cages, where further matings occur among the females not previously mated.

A modification which was adopted generally in the work here in British Guiana was to place *Diatraea* larvae directly into cane-shoots after they were

infested with the parasite. This considerably shortened the work and the recovery of parasites from such larvae was equally as good as, if not in fact better than, with the tins.

At first large circular cages 24 inches high and 18 inches in diameter were used for mating, but later, when it was discovered that the size of cage did not affect mating, smaller cages were adopted and cages 18 inches high and 14 inches in diameter were used as standard. In these cages, under suitable conditions, mating takes place readily, and they serve also to store flies until they are liberated in the fields. These cages have four uprights and a single cross-bar at one end by which they are suspended, and were made of ¼-inch iron-rod welded at the joints. To each frame a bottom pan of galvanised iron with sides 1½ inches high is fitted and wired into position; the whole is enamelled white. A cylindrical cover of mosquito net, made to fit tightly and in the sides of which are two sleeves, is drawn over the frame and is closed by means of tapes at the top and bottom. When flies are being kept in a cage, a circular piece of gunny-bag (sugar bag) is placed in the bottom and this is kept constantly damp. Two glass receptacles (Syracuse watch-glasses), one containing sugar and the other a piece of cotton wool saturated with water, are placed in each cage, while in addition a bowl of water in which is standing grass (*Paspalum repens*) may be included.

It has been found that infesting the *Diatraea* larvae with the parasite is best accomplished by means of a fine sable-hair brush, and good quality water-colour brushes of No. 1 size proved very suitable. Further, in doing this, if a number of larvae are removed from the salt solution at one time and placed on a black plate in a vertical line, it facilitates the work of infesting, as they may readily be seen as they walk out of line about the black plate. By this method assistants are usually able to work without the aid of even a low-power lens, but for less keen eyes a circular reading glass about 3 inches in diameter mounted in a flexible arm proved a very useful aid.

Each *Diatraea* larva is wetted with a dab of salt solution before the parasite larvae are placed on it, and what was found to work even better was to keep the larvae (*D. saccharalis*) in glass tumblers and to transfer lots of 10 larvae at a time to a petri dish containing salt solution prior to infestation, the larvae being taken from this dish and infested immediately.

Should the *Diatraea* larvae be about full-grown, two parasite larvae are placed upon them (these are referred to as "doubles"), while if they are about third instar or rather undersized, they are infested with only one parasite larvae ("singles"). Small larvae are not infested.

If the tin method is used, a piece of blotting or filter paper wetted with salt solution placed in each tin greatly improves the chances of survival of parasite larvae which may drop or crawl from the host after it has been infested, and the

infestation is greatly improved by this means. A thin coating of paraffin wax applied to the inside of each tin retards corrosion and so prolongs the useful period of these receptacles.

In the direct shoot method the infested larvae are placed in small cane-shoots in which a small pit has been cut previously, and as each larva is placed in the shoot and directly infested a small rubber band is placed round it to keep it closed. Subsequently shoots with infested larvae to a total of ten are slipped under one band, and they are placed in such bundles in the storage tins.

The cages used for storing cane-shoots containing infested larvae are galvanised iron cylinders (known as the "body") to which are fitted tops and bottoms, and are of two sizes, namely, 11 inches high by 10 inches diameter, and 11 inches high by 7 inches diameter. In each body about half-way between the top and bottom edges is cut a circular hole of 2¾ inches diameter around which is soldered a rim one inch high. The tops and bottoms are made to fit tightly inside the body so as to prevent the egress of *Diatraea* larvae, or when an outside cover is fitted a bead of about ¼ inch projection is inscribed around the body about 1½ inches from the top and bottom edges so that when the covers are in their places their edges come in contact with the bead, so making the body secure against the escape of the *Diatraea* larvae. To the circular opening in the body is fitted a cap of mosquito wire-mesh which affords ventilation to the cages and prevents excessive condensation of moisture within.

In storing the cane-shoots in these tins a layer of damp bagasse or sawdust is placed in the bottom pan and the shoots with the contained larvae stood upon this. It is essential to the production of parasite puparia that the moisture in these tins should be regulated to prevent the drying out of the shoots or the development of excessive moisture, which causes the formation of moulds. The temperature in these tins is surprisingly low and constant when thus prepared and is in the vicinity of 29–30°C. even when there is a good deal of heat being generated by the rotting cane-shoots; the relative humidity being in the vicinity of 100 per cent. The storage tins are each numbered on the body, top and bottom, from 1 to 31 and the shoots stored therein according to the date of the month on which the contained larvae were infested, "doubles" and "singles" being kept separately for the purpose of working out the percentage of recovery.

After the cane-shoots have been stored thus for 12 days, balloon fly-traps are fitted to the opening, the circular cap being first removed, and in a day or so the flies commence to emerge. The balloon fly-traps fitted to these tins were of local construction and measured 9 inches long by 2¾ inches in diameter with a cone about 3 inches high, the top being made in the form of a cap which was readily removeable to allow of the transference of the flies.

In practice, these balloon traps were often abandoned, however, and the puparia actually searched for by tearing apart the shoots. This was rendered somewhat easier than may be generally imagined by the decay of the shoots, and assistants with nimble fingers do not injure many puparia.

The puparia obtained are then placed on damp bagasse or sawdust in 2 lb. jam bottles covered with wire-gauze tops.

The method of storing in tins and securing the flies in traps, if it does not greatly increase the number of flies obtained, certainly effects a considerable saving in time, and on the whole is a marked improvement on the former practice, but for estate practice the searching method was generally preferred.

Mated female flies kept for laboratory use are confined in 2 lb. jam bottles from which the central area of the cover has been cut and mosquito wire-gauze substituted. In each bottle is placed a piece of blotting paper on which there are a few crystals of sugar. One lb. jam bottles may also be used for this purpose and have proved entirely satisfactory. The sugar used must be either granulated white or dark crystal (muscovado).

It was found convenient when working in small spaces, as were most of the insectaries used in the work, to suspend the mating cages from the top of the insectary, and to arrange a counterpoising weight run over a couple of pulleys to allow the easy lowering and raising of the cages. The mating cages in the present instance weighed approximately 10 lb. and as counterpoising weights sash window weights or small bags filled with sand were used. Double-decked tables are also a great saving in space.

Temperature and humidity both play an important part in the artificial rearing of the insect (as will be observed from the statements made elsewhere in this paper) and must be regulated as far as possible. The methods used in obtaining the desired temperatures and humidities have already been mentioned. It remains only to say that in the storage tins for shoots the temperature was much less than would be generally imagined with the decay of shoots taking place therein, and was generally found to be about 30°C. while the humidity was in most instances nearly 100 per cent. R.H. In the laboratory temperature and humidity readings are taken three times a day, namely 8 a.m., 1 p.m., and 4 p.m., and there is also a self-recording thermo-hygrograph.

Laboratories.—A laboratory was erected for the investigation on the Sugar Experiment Station from a free grant made to the Colony by the Empire Marketing Board for the purposes of sugar-cane research. A portion of equipment was also met from this grant. Later, with the actual introduction of the Amazon fly it was found necessary to enlarge the laboratory as well as to add to the equipment and apparatus, and this was met by funds provided by the British Guiana Sugar Producers' Association.

The laboratory as first erected was a small detached building 37 ft. long by 17 ft. wide, of wood framing and concrete stucco panels, raised on concrete pillars 3 ft. high, a part of the building measuring 9 ft. by 17 ft. being screened with brass mosquito wire-mesh for use as an insectary. In order to protect the insectary against driving rains three small sloping glass roofs were affixed around the exterior. Later the building was enlarged by extending the insectary a further 10 ft,

On the sugar estates there has been a great diversity of type of insectaries, as might be expected, it being very often a matter of making an existing building serve the purpose; thus we have worked in structures varying from what might be considered as ideal for a field laboratory with well-made benches and adequate apparatus, housed in a good building properly painted, to a structure that started its life as a large dog-kennel and immediately prior to the work was a calf-pen with a low, leaky roof and roughly put-together benches of undressed wood.

The size of the insectaries used throughout the work both at headquarters and on the estates approximates 324 sq. ft., being roughly 18 ft. by 18 ft. With three assistants working, some 200 to 300 flies per day were produced in such laboratories, the number being regulated largely by supplies of *Diatraea* larvae from the fields.

Colonisation of the Sugar Estates.—At the time of the arrival of the first consignment of the parasite nothing was known of its bionomics, and the small number of flies (3) obtained from this shipment did not allow of any knowledge being obtained in this respect. So that when the second consignment arrived it was still unknown whether the insect would be amenable to laboratory rearing.

It was decided, therefore, to make liberations directly into fields of some of the adult flies emerging from the consignments pending the investigation of the bionomics of the insect and the matter of laboratory rearing. Accordingly, liberations of flies from the 3rd and 4th consignments were made in September and October.

At that time the weather was hot and dry, as is usual at this period, and *Diatraea* was generally scarce, and of those present *D. canella* predominated. No recoveries from these liberations were recorded and, as mentioned elsewhere, it is believed now that this was largely due to the preponderance of *D. canella* in the fields in which the liberations were made.

Liberations of this nature were made also with flies from the 5th and 6th consignments. During the first week in November (2nd and 9th) in a field of plant canes at Pln. Non Pareil (NP 29) 314 flies were liberated, and on 22nd November two puparia were found in a single bored shoot from which, on the following day, two Amazon flies emerged. Thus about three months after the arrival of the first flies in British Guiana the first recovery of the parasite was made.

In the meantime it was found that the technique which had been employed in connexion with the rearing of *Lixophaga* was also applicable to *Metagonistylum* and laboratory rearings had already been commenced. *Diatraea* had been infested in the laboratory as early as 21st September from flies of the 2nd consignment, which arrived on 12th September and from which the first flies emerged on the following day, and the first laboratory reared flies were obtained on 7th October, 1933.

From that date regular laboratory rearings continued. For the next eighteen months, and during the course of the work under the Colonial Development Fund grant, flies were reared and liberated on, or breeding stock supplied to, every sugar estate in the Colony.

Liberations having been made under suitable conditions, it was usually but a few weeks before recovery of the parasite could be made.

At the commencement the headquarters laboratory undertook the rearing of all flies and supplying of estates, the *Diatraea* larvae for use in the laboratory being sent in by different plantations. As time went on it became evident that if the entire sugar-growing area was to be stocked within a reasonably short period it would be necessary to produce much greater numbers of the fly than the facilities of the headquarters laboratory would allow. Accordingly, the co-operation of the sugar estate authorities was sought, and readily obtained, and arrangements were made to start rearing the insect in field laboratories on certain of the larger plantations. Assistants for work in these laboratories were obtained from the estates themselves with the aid of the managers and these were trained in the technique of rearing the insects at the headquarters laboratory. Ten such field laboratories were thus established on estates. These laboratories, with the exception of Pln. Albion were directly under the supervision of the writer; the laboratory at Pln. Albion was under Mr. H. W. B. Moore, entomologist of that estate. These laboratories were established at centres that were some distance away from headquarters and to which it would have been difficult to send continuous supplies, or where the area under the control of one group was large and it was more convenient to do this. For the nearer plantations as well as the smaller ones, headquarters laboratory supplied flies up to March 1935, when the grant terminated and the writer went on leave.

Careful supervision was maintained over the work of these laboratories. A weekly report on the working of each laboratory was received and frequent visits were paid to them as appeared necessary. As to the efficiency of the work at these field laboratories it may be stated that it was generally satisfactory and in some instances it reached a very high standard, the recovery of puparia having reached as high as 96 per cent. larvae infested, while the recovery of flies reached 95 per cent. puparia.

Up to the time of the termination of the grant (March 1935) that is, at the end of eighteen months, some 195,677 flies had been reared in all laboratories. Of this number, 25,226 or 12.8 per cent. were produced at the headquarters laboratory.

Since that time some 180,020 more flies have been produced on the sugar estates, making a grand total of 379,697 flies produced in all laboratories over the period of two years since its introduction.

The actual number of flies which were liberated was, however, considerably less than the figures given above. As regards headquarters laboratory, a total of 25,339 flies was reared during 1933-35 and 18,174 were distributed, that is, 71.7 per cent. In addition, some 2,000 flies were used in the laboratory,

6. Cost of Introducing the Parasite.

It is difficult to state any exact figure of the cost of introducing the Amazon fly into British Guiana owing to the conditions and arrangements under which the work was carried out. Nevertheless, a figure, which for general purposes may be taken as representative of the cost of the introduction of the parasite, has been arrived at and in order to complete this record it is felt that it should be included here.

As has been stated previously, the British Guiana Sugar Producers' Association provided funds to the extent of £2,000 for the actual cost of the introduction. This amount provided for the purchase of a special launch for work on the Amazon and its transportation through British Guiana thence, the transportation of the personnel and supplies of the expedition, the pay of such members of the expedition as were specially engaged for the purpose, the expenses of collecting the parasite in Brazil and its shipment to the Colony, and the pay of the junior laboratory staff at Georgetown.

Other charges which should be included properly in the cost of the introduction, but which were in fact not thus charged but were paid either from Imperial, Colonial, or other funds, would be the salaries of both Dr. Myers and the writer.

Making allowances for such charges and also for some other incidental expenses, but not including previous ecological work done on *Diatraea*, the total cost of introducing the fly into British Guiana, as distinct from the colonisation of the estates, that is, for the work covering the period April to December 1933, did not exceed £5,000 ($24,000).

From the material received in the Colony it has been shown that 1,400 flies were secured, and basing the cost on this number only, the cost per fly was $17.10. In actual fact, by the end of December 1933, some 3,384 flies had been obtained (including 1,400 in original shipments) and of these, some 2,690 flies had been distributed to the sugar estates, and if the costs are worked on this latter figure of 2,690 flies, the cost per fly was only $8.92 or £1 17*s*. 2*d*.

7. Parasitism of *Diatraea saccharalis* in Rice and other Host-plants.

The Amazon Fly has been observed to parasitize *Diatraea saccharalis* in this Colony in other host-plants as well as sugar-cane. Only a few months after its introduction the fly was recorded as parasitizing *D. saccharalis* in the rice fields adjacent to the Sugar Experiment Station where the headquarters laboratory was situated, and later it was recorded in this host-plant in other localities as well.

Since that time there have been observed a number of instances of parasitism of *D. saccharalis* in rice. During the past year this parasitism appears to have increased, but no data are available to confirm this.

That *D. saccharalis* in rice should be attacked is not surprising; in fact, it was what was expected, for the aquatic nature of the crop offers conditions which it seems would be favourable to the development of the fly. The importance of this lies in the fact that rice, which is the second important crop of the Colony, is at times seriously attacked by *D. saccharalis* and at all times acts as an important alternative crop for the pest.

On sugar estates either in cane-fields or rice-fields or in their immediate vicinity, the Amazon fly has been recorded also as attacking *D. saccharalis* in the grass hosts *Echinochloa polystachya* (HBK), Hitch., *E. crusgalli cruspavoris* (HBK), Hitch., "Bamboo Grass," *Hymenachne amplexicaulis* (Rudge), Ness., "Bissy-bissy," *Cyperus articulatus*, L., and Para Grass, *Panicum barbinode*, Prin.

8. Status in 1937.

Examinations made on sugar estates at different times after the introduction of the Amazon fly into this country showed long since that the insect had established itself not only in sugar-cane but also in rice. and as regards the former crop at least was parasitizing a fair proportion of the *Diatraea saccharalis* in that host-plant.

A survey carried out about the middle of 1935 by Mr. F. A. Squire, while engaged as Supernumerary Entomologist in this Department, showed further that some two years after the introduction of the parasite and the colonisation of the sugar estates the insect was still doing good work. The results of this survey were not published.

About a year ago it was considered desirable to undertake another survey, and in January 1937, the work was commenced, continuing as opportunity allowed, to January 1938. In the survey it was not possible to carry out examinations of all the sugar estates in the Colony, but fifteen sugar estates were examined extending from Pln. Skeldon on the extreme east of the Colony to Pln. Versailles and Schoon Ord on the West Bank of the Demerara River. It is believed that the number of estates examined and the area over which they are extended are sufficient to allow the results to be considered as being representative of the general conditions over the sugar-growing area.

As regards Pln. Albion, Berbice, the survey of that estate was carried out in conjunction with Mr. H. W. B. Moore, entomologist of that estate, who undertook the field collections of material.

A total of 212 fields was examined, comprising 88 plant fields, 54 first ratoons, 56 second ratoons and 14 third ratoons. In 155 fields (73.1 per cent.) the Amazon fly was found parasitizing either *D. saccharalis* or *D. canella* or both, 144 fields showing a parasitism of *D. saccharalis* only, but no field was found in which only *D. canella* was parasitized.

In these fields a total of 37,332 "deadhearts" were cut out, of which 20,998 or 56.3 per cent. were empty. Of the remainder, 14,274 (37.9 per cent. of the

total) contained living *Diatraea*, in the proportion of 6,271 or 43.9 per cent. *D. saccharalis* (the black-headed borer) and 8,003 or 56.1 per cent. *D. canella* (the yellow-headed borer); 2,060 or 5.5 per cent. of the "deadhearts" were the result of other causes, including white grubs (hard-back beetles) and rats.

In 5,371 *D. saccharalis* found in positive fields, 863 (16.0 per cent.) were found to be parasitized by the Amazon fly at the time of examinations of the fields, the parasitism ranging from 3.4 per cent. to 36.2 per cent. While of the total of 212 fields, 39 (18.4 per cent.) showed parasitisms of *D. saccharalis* of 30 per cent. and over. If, however, all the fields examined are included, both positive and negative, the parasitism works out at 13.7 per cent. *D. saccharalis.*

The parasitism for *D. canella*, as expected, was low, 0.32 per cent. for positive fields and 0.23 per cent. for all fields.

Records were kept during the survey as to the number of parasites per host. Of a total of 863 *Diatraea saccharalis* records, it was found that 513 or 59.4 per cent. contained only a single parasite, 263 (30.5 per cent.) contained two parasites, 66 (7.6 per cent.) contained three parasites, 17 (1.9 per cent.) four parasites, and only 4 (0.5 per cent.) contained five parasites per host.

The puparia of the fly found in the field agreed very closely with these figures and were in the proportions of 59.4, 31.4, 7.5, 1.4 and 0.3 per cent. for one, two, three, four and five parasites per host respectively.

In January 1937, Mr. H. W. B. Moore recorded a hyperparasite of the Amazon Fly from Pln. Albion, Berbice.

This appearance of a hyperparasite was not unexpected, for it had long been known that the native fly parasite of *Diatraea*, *Leskiopalpus (Stomatodexia) diadema*, Wied., was attacked by the hyperparasite *Signiphora dipterophaga*, Girault, and the possibility of this insect attacking *Metagonistylum* was well recognized at the time of the introduction of the Amazon fly. This was confirmed when a determination of the insect was made by Dr. C. Ferrière of the Imperial Institute of Entomology.

In addition, Squire (16), in his report of 1935, had mentioned the finding of a puparium of *Metagonistylum* which had apparently been attacked by a hyperparasite, although he did not obtain any specimens of the insect.

Accordingly, during the survey, precautions were taken to secure hyperparasites in order to obtain data as to the prevalence of the insect.

On four estates of the fifteen the hyperparasite was obtained, namely, Plns. Port Mourant, Albion, Diamond and Farm. This would indicate that the hyperparasite is well distributed over the sugar area.

Of the 45 fields examined on these estates, in 13 (29 per cent.) hyperparasites were found, while of 178 puparia collected, 17 (9.6 per cent.) produced

hyperparasites. If, however, the whole Amazon fly population of these fields is considered, namely 516 larvae and puparia, the percentage destroyed by hyperparasites would be only 3.3 per cent.

Commenting on the larval parasitism, Myers (11) in his review of the *Diatraea* situation in British Guiana in 1931, stated that the combined parasitism of the eight important parasites was 6.9 per cent. of the borers in cane. The larval parasitism by the Amazon fly of 16.0 per cent. *D. saccharalis*, in the present survey must, therefore, be considered as very satisfactory.

9. Shipments of the Parasite to the West Indies.

While perhaps not strictly within the scope of this report, in order to make the account of the work in the Colony complete, opportunity is taken here to make mention of shipments of the Amazon fly which have been made from British Guiana since its establishment here.

St. Lucia.—As the result of a request from the Sugar Planters of St. Lucia, B.W.I., to the Brittsh Guiana Sugar Producers' Association, a shipment of puparia of the Amazon fly was made to that island in November, 1934. The shipment was made by the writer direct to Mr. Harold E. Box, entomologist engaged under the Colonial Development Fund, who was at the time stationed in St. Lucia (3).

Two hundred and twenty puparia of the fly were despatched by air mail from Georgetown on 27th November 1934, and arrived at St. Lucia the following day. Mr. Box subsequently reported that the puparia were received in good condition. Rearings of the fly were undertaken and the establishment of the insect in St. Lucia has formed the subject of a report by Mr. Box.

Puerto Rico.—In December 1935, Mr S. M. Dohanian, of the Puerto Rico Experiment Station of the United States Department of Agriculture came to the Colony to obtain material of the parasite for shipment to Puerto Rico. Mr. Dohanian remained in the Colony until February 1936, during which period some 6,000 adult Amazon flies were sent by him by air mail to Puerto Rico. Consequent on the failure of the fly to establish itself in Puerto Rico, Dr. K. A. Bartlett, also of the Puerto Rico Experiment Station, visited the Colony in September 1937 and made further shipments of the fly to Puerto Rico.

Trinidad.—At the request of the Director of Agriculture, Trinidad, and with the approval of the British Guiana Sugar Producers' Association, shipments of the parasite totalling some 800 puparia were made to Trinidad in September and October 1936. These shipments were made by the writer and were received by Mr. A. H. Pickles, entomologist, Department of Agriculture, Trinidad.

More recently, a further small consignment of flies was sent to Trinidad by Dr. K. A. Bartlett while he was in the Colony.

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Firstly, I would mention Dr. J. G. Myers, with whom I was associated both in this work and for some period before, during which the purely ecological investigations on *Diatraea* were undertaken.

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References.

1. Aldrich, J. M. (1933). Two reared species of Tachinids from South America.—Proc. Biol. Soc. Wash, **35**, pp. 170-173, 1 fig.

2. Box, H. E. (1933.) Outline of work in Antigua and St. Kitts during the year 1932.—Report on the introduction and establishment of the Cuban parasite, *Lixophaga diatraea* Townsend. Antigua, p. 40.

3. ——. (1933). Further observations on Sugar-Cane moth borers (*Diatraea* spp.) in St. Lucia. Introduction of the Cuban Parasite *Lixophaga diatraea* Townsend. Report upon a visit to St. Lucia, August–September 1933, with an Appendix on the recommended biological Control of the White Coffee-leaf Miner (*Leucoptera coffeella*, Guér.) in St. Lucia.—10 pp. 7 refs. Castries.

4. Cleare, L. D. (1934). Sugar-Cane moth-borer investigations in British Guiana: the present position.—Agric. J. Brit. Guiana. **5**, pp. 13–21.

5. ——. (1937). Experimental rearings of the Amazon fly *Metagonistylum*) *minense* Towns.) on the yellow-headed sugar-cane moth-borer (*Diatraea canella* Hmpsn.),—Agric. J. Brit. Guiana, **8**, pp. 190–194.

6. ——. (1938.) Status of the Amazon fly in British Guiana, 1937.—Agric. J. Brit. Guiana, **9**, pp. 12–24.

7. Dohanian, S. M. (1937). The introduction of parasites of the sugar-cane borer into Puerto Rico.—J. Agric. Univ. Puerto Rico, **21**, pp. 237-241.

8. Dohanian, S. M. (1937). The search in the American tropics for beneficial insects for introduction into Puerto Rico.—Agric. Notes P. Rico Exp. Sta. Mayaguez, P.R. no. 76, 7 pp.

9. HARLAND, S. C. (1937). A note on two larval parasites of the sugar-cane moth-borer, in São Paulo, Brazil.—Trop. Agric. **14**, p. 280.

10. MONTE, O. (1933). Um novo parasita da broca da cana (*Diatraea saccharalis* F.) e consideraçoes sobre esta broca.—Bol. Agric. Zootec. Vet., **6**, pp. 559–563, 3 figs.

11. MYERS, J. G. (1931). Preliminary report on an investigation into the biological control of West Indian insect pests.—E.M.B., **42**, 173 pp. 2 maps. H.M.S.O. London.

12. ——. (1934). The discovery and introduction of the Amazon fly—a new parasite of cane-borers (*Diatraea* spp.).—Trop. Agric., **11**, pp. 191–195.

13. ——. (1935). Second report on an investigation into the biological control of West Indian insect pests.—Bull. Ent. Res., **26**, pp. 181–252, 1 map.

14. ——. (1936). Biological control of sugar-cane pests in the British West Indies and British Guiana.—Proc. Int. Soc. Sugar-Cane Techn. **5**, Brisbane, 1935, pp. 381–385.

15. SCARAMUZZA, L. C. (1930). Preliminary report on a study of the biology of *Lixophaga diatraeu*, Tns.—J. Econ. Ent., **23**, pp. 999–1004.

16. ——. (1933). Observations on certain *Diatraea* parasites of Brazil and British Guiana.—Proc. 7th Ann. Conf. Asoc. Tecnicos Azucareros de Cuba, pp. 60–64.

17. SQUIRE, F. A. (1935). Progress report on the present status of the Amazon fly in British Guiana. (Unpublished Rep., Col. Devpmt. Fund.)

18. THOMPSON, W. R. (1930). The biological control of insect and plant pests. —E.M.B.. **29**, 124 pp. H.M.S.O., London.

19. TOWNSEND, C. H. T. (1927). Synopse dos generos muscoideos de região, humida tropical da America, com generos e especies novas.—Rev. Mus. Paulista, **15**, pp. 205–385, 4 pls.

TESTING LARGE NUMBERS OF RICE VARIETIES BY THE QUASI-FACTORIAL METHOD.

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INTRODUCTION.

The plant breeder usually has to handle large numbers of varieties and strains and his function consists largely in selecting promising, and discarding unpromising, material from that at his disposal. He must therefore have some means of testing which will enable him to assess the capabilities of such large numbers quickly and precisely.

Replicated variety trials, in the form of randomised blocks or Latin squares, offer an efficient means of comparing the few superior varieties which emerge from the bulk of the plant breeding material; but the initial processes of sifting and discarding involve the testing of too large a number to be satisfactorily handled in this way. As Yates points out "a Latin square containing the whole of the varieties is impossible, being both too unwieldy and requiring too many replications, and even randomised blocks containing the whole of the varieties are unsatisfactory, for the blocks are likely to contain too many plots to eliminate fertility differences efficiently."

Yates however has recently developed a new technique for testing large numbers. He calls it the Pseudo-factorial (Quasi-factorial in a more recent publication) arrangement and the Incomplete Randomised Block method.

At the Rice Experiment Station, British Guiana, it has been the custom to base the preliminary judgment of a variety on its average performance in progeny rows, over a number of seasons, as compared with the progeny row yields of the standard varieties, each variety being planted in a progeny row plot consisting of 10 rows, each 1 foot apart, with 34 plants per row also spaced 1 foot apart. Progeny rows are admirable for acclimatising exotic, and purifying impure, varieties and they serve a very useful purpose as small observation plots, but their yield figures can give only a rough idea of varietal yielding power, since owing to lack of replication, no estimate of the error due to soil heterogeneity, etc., can be made. Some effort may be made to remove soil variability by using systematically placed controls or checks, but Yates has demonstrated that this is not likely to prove more efficient than the quasi-factorial arrangement. The quasi-factorial arrangement was tried here for the first time in 1938 and proved so useful that it was thought that a description of the experiment and results might be of interest to other workers in this field.

METHOD.

With numbers above 100 and up to 200, the quasi-factorial method with two or three groups of sets seems to be the most useful, since the large number of replications required in the incomplete randomised block method is hardly possible on account of many reasons, economic chiefly. In view of the fact that in the method with two groups of sets, too great a discrepancy may occur between estimates of error variance for comparing varieties in the same and in different sets, it was thought advisable to use the method with three groups of sets.

169 varieties were tested, of which 70 were old selections made before 1937, 41 were new selections made in 1937, 27 were hybrids bred at the station, and 31 were imported foreign varieties.

With the varieties in each set (p) = 13, the total number of varieties tested was 169 ($= p^2$). These are arranged in a square, the varieties being designated by numbers u v w, using the first figure u to represent the rows, the second v to represent columns, and the third figure w being written in along the diagonals. The following square is obtained :

1 1 1	1 2.13	1 3.12	. . . . .	1.11.4	1.12.3	1.13.2
2 1 2	2 2 1	2 3.13	. . . . .	2.11.5	2.12.4	2.13.3
3 1 3	3 2 2	3 3 1	. . . . .	3.11.6	3.12.5	3.13.4
11.1.11	11.2.10	11.3.9	. . . . .	11.11.1	11.12.13	11.13.12
12.1.12	12.2.11	12.3.10	. . . . .	12.11.2	12.12.1	12.13.13
13.1.13	13.2.12	13.3.11	. . . . .	13.11.3	13.12.2	13.13.1

Three groups X, Y, Z are then written out as follows :

Group X : as above

Group Y : obtained from Group X by writing in rows for columns, and colums for rows, thus :

1 1 1	2 1 2	3 1 3	. . . . .	11.1.11	12.1.12	13 1.13
1 2.13	2 2 1	3 2 2	. . . . .	11.2.10	12.2.11	13.2.12
1 3.12	2 3.13	3 3 1	. . . . .	11.3.9	12.3.10	13.3.11
1.11.4	2.11.5	3.11.6	. . . .	11.11.1	12.11.2	13.11.3
1.12.3	2.12.4	3.12.5	. . . . .	11,12.13	12.12.1	13.12.2
1.13.2	2.13.3	3.13.4	. . . . .	11.13.12	12.13,13	13.13.1

Group Z : obtained from Group X by writing in the diagonals along the rows, thus :

1 1 1	2 2 1	3 3 1	. . . . . .	11.11.1	12.12.1	13.13.1
2 1 2	3 2 2	4 3 2	. . . . . .	12.11.2	13.12.2	1.13.2
3 1 3	4 2 3	5 3 3	. . . .	13.11.3	1.12.3	2.13 3
11.1.11	12.2.11	13.3.11	. . . . .	8.11.11	9.12.11	10.13.11
12.1.12	13.2.13	1 3.12	. . .	9.11 12	10.12.12	11.13.12
13.1.13	1 2.13	2 3.13	. . .	10.11.13	11.12.13	12.13.13

STATISTICAL CALCULATIONS.

Total number of sets = 3p = 39.

Each group is replicated twice, so that

Replications of each group	(n)	= 2	
Complete replications	(r)	= 3n	= 6
Total number of blocks	(b)	= 3np	= 78
Total number of plots	(N)	= $3np^2$	= 1014

Each plot consists of two rows of plants 1 foot apart, spaced 1 foot apart within the rows. Each row contains 34 plants. The sets were not arranged at random within each group, but the varieties were randomised within each block. The groups were laid down at random on the field. All yields are given in ounces. There were three groups X_1, Y_1, Z_1, each with its replication X_2, Y_2, Z_2.

The first step in the computations is to set out the yields of the individual plots as in Table I, where the yields of the first replication of the first group (X_1) are shown with the marginal block totals. To save space only a few sets are shown. These yields are then summed for each group: this is shown also in Table I for the group X where the figures represent the totals of the yields in X_1 and X_2, and the marginal totals Xu.. and X.v. are collected according to set. It is now easy to tabulate the variety totals Tuvw as shown; this is done in two ways so as to give the marginal totals Tu.., T.v. and T..w which are required in the next step.

The next step is to prepare a table of the quantities Cu.., C.v. and C..w. These are correction terms based on the yields of the other varieties in the same set and values are obtained for every set in each group, these values being given by $\frac{Tu.. - 3Xu..}{6np}$, $\frac{T.v. - 3Y.v.}{6np}$ and $\frac{T..w - 3Z..w}{6np}$. Application of these correction terms to the actual means of the variety totals will result in the corrected mean yields shown at the bottom of Table I. Cu.. and C.v. are

TABLE I.

Varieties after Randomisation and Corresponding Plot Yields in Groug X_1.

													Block Totals.
(1.11 4) 108.00	(1 9 6) 91.25	(1.12 3) 75 00	(1 1 1) 86.00	(1.13.2) 85 00	(1 7 8) 63.50	(1 6 9) 72.00	(1.10.5) 70.25	(1 8 7) 93.25	(1 5 10) 85.75	(1 2.13) 76.50	(1 3.12) 94.75	(1 4.11) 91.00	1092.25
(2.13.3) 67.25	(2 7 9) 93.00	(2 9 7) 67.75	(2 5.11) 81.25	(2 6.10) 93.75	(2.11.5) 74.25	(2.12.4) 83.00	(2 2 1) 79.00	(2 1 2) 73.50	(2 4 12) 107.75	(2 3.13) 95.75	(2.10.6) 73.00	(2 8 8) 84.50	1073.75
...	...	...	...	...	...	..	...	...	...	...	...	...	...

Variety Totals by Groups and for Groups combined—Group X showing values of X_{uvw}.

														Xu . .
	(1 1 1) 157.50	(1 2.13) 168.25	(1 3.12) 186.25	(1 4.11) 190 50	(1 5.10) 169.50	(1 6 9) 147.75	(1 7 8) 135.25	(1 8 7) 186.50	(1 9 6) 175.00	(1.10.5) 165.75	(1.11.4) 202.00	(1.12.3) 154.50	(1.13.2) 162.00	2200.75
	(2 1 2) 156.50	(2 2 1) 177.25	(2 3.13) 192.00	(2 4.12) 211.25	(2 5.11) 165.50	(2 6.10) 199.75	(2 7 9) 180.75	(2 8 8) 178.00	(2 9 7) 148.00	(2.10.6) 160.25	(2.11.5) 166.25	(2.12.4) 163.75	(2.13.3) 132.00	2231.25
	...	...	...	...	...	...	...	...	...	...	...	...	...	...
X.v.	1986.25	2006.50	2145 50	2188.00	1917.00	2037.00	2145.25	2082.75	2061.75	2169.00	2192.50	1864.00	2012.00	26807.50 =X . . .

Variety Totals—T_{uvw}.

														Tu . .
	(1 1 1) 484.00	(1 2.13) 477.50	(1 3.12) 540.00	(1 4.11) 518.50	(1 5.10) 477.75	(1 6 9) 444.25	(1 7 8) 397.00	(1 8 7) 504.75	(1 9 6) 503.75	(1.10.5) 550.00	(1 11 4) 535.75	(1.12.3) 420.00	(1.13 2) 494.75	6348.00
	(2 1 2) 500.25	(2 2 1) 550.75	(2 3.13) 521.75	(2 4.12) 616.25	(2 5 11) 491.75	(2 6.10) 603.75	(2 7 9) 483.00	(2 8 8) 528.25	(2 9 7) 457.75	(2.10.6) 450.75	(2.11 5) 499.25	(2.12.4) 465.75	(2.13.3) 358.75	6528.00
	...	...	...	...	...	...	. .	...	...	...	...	...	...	...
T.v.	6258.25	6323.75	6438.00	6553.00	5988.75	6317.50	6439.75	6385.25	6135.00	6381.75	6342.75	5314.00	5694.75	80572.50 =T . . .

TABLE I.—(*Continued.*)

Correction Terms..

	Tu..	3Xu..	Tu..−3Xu..	Cu..	T.v.	3Y.v.	T v −3Y.v.	C.v.	T..w	3Z..w	T..w−3Z..w	C..w
1	6348.00	6602.25	−254.25	−1.630	6258.25	6710.75	−452.50	−3.142	6545.25	6844.50	−299.25	−1.918
2	6528.00	6693.75	−165.75	−1.063	6323.75	6751.50	−427.75	−2.742	6025.75	6089.25	− 63.50	−0.407
...	...	...	...	...	...	..	...	..	...	...	...	...
13	5084.25	5014.50	− 69.75	−0.447	5694.75	5283.75	+410.50	+2.631	6053.00	5625.00	+428.00	+2.744

Corrected Mean Yields—t_{uvw}.

(1 1 1) 73.977	(1 2.13) 77.955	(1 3 12) 88.227	(1 4.11) 84.686	(1 5.10) 75.354	(1 6 9) 73.050	(1 7 8) 63.302	(1 8 7) 82.272	(1 9 6) 81.896	(1.10 5) 90.370	(1.11.4) 89.799	(1.12.3) 69.769	(1.13 2) 83.052
(2 1 2) 78.763	(2 2 1) 86.069	(2 3 13) 87.754	(2 4 12) 100.086	(2 5 11) 80.662	(2 6.10) 96.822	(2 7 9) 81.753	(2 8 8) 86.495	(2 9 7) 75.998	(2.10.6) 74.154	(2.11.5) 83.869	(2.12.4) 79.166	(2 13.3) 60.488

in the corresponding row and column of the table, but C..w has to be picked out from the value w for the variety. Thus,

$$t_{12.13}=\frac{477.50}{6} - 1.630 - 2.742 + 2.744 = 77.955.$$

For the analysis of variance the sums of squares are required for total, blocks and varieties. The first two are calculated in the usual way. The sum of squares of varietes is calculated according to the following scheme :

$$
\begin{array}{lll}
\Sigma\,(Tuvw^2)/\,3n & = & 6{,}585{,}602.0729 \\
\left.\begin{array}{l} +\ \Sigma\,(3Xu..-Tu..)^2/6np \\ +\ \Sigma\,(3Y.v.-T.v.)^2/6np \\ +\ \Sigma\,(3Z..w-T..w)^2/6np \end{array}\right\} & = & 18{,}380.4960 \\
\left.\begin{array}{l} -\ (3X\,...-T\,...)^2/18np^2 \\ -\ (3Y\,...-T\,...)^2/18np^2 \\ -\ (3Z\,...-T\,...)^2/18np^2 \end{array}\right\} & = - & 639.8521 \\
\left.\begin{array}{l} -\ \Sigma\,(Xu..^2)/np \\ -\ \Sigma\,(Y.v.^2)/np \\ -\ \Sigma\,(Z..w^2)/np \end{array}\right\} & = & -6{,}451{,}900.7152 \\
\qquad\qquad \text{s.s. (varieties)} & = & 151{,}441.9716
\end{array}
$$

In this scheme the sum of squares for (groups + sets + varieties + mean) is given by

$$\frac{\Sigma\,(Tuvw^2)}{3n} + \frac{\Sigma\,(3Xu..-Tu..)^2 + \Sigma\,(3Y.v.-T.v.)^2 + \Sigma\,(3Z..w-T..w)^2}{6np}$$

$$- \frac{(3X...-T...)^2 + (3Y...-T...)^2 + (3Z...-T...)^2}{18np^2}$$

and the sum of squares for (groups + sets + mean) is determined from $\frac{\Sigma\,(Xu..^2) + \Sigma\,(Y.v.^2) + \Sigma\,(Z..w^2)}{np}$. The difference gives the sum of squares for varieties.

The analysis of variance now reads as follows :

	S.S.	D.F.	Variance	½ log e^V	Calc. value of Z
Blocks	93,713.9786	77			
Varieties	151,441.9716	168	901.4403	3.4020	1.3620
Error	56,935.8697	768	72.0519	2.1400	
Total	301,091.8199	1013			

The required observed values of Z at the 5 per cent. and 1 per cent. points do not exceed .2654 and .3746, indicating that varietal differences are significant.

In making comparisons the varieties may be classified according to whether they occur or do not occur in the same set, *i.e.*, differing in two sets or three sets.

If s^2 is the error variance, the variance of the difference between the means of varieties occuring in the same set is

$$V(t_{uvw} - t_{uv'w'}) = \frac{2s^2}{3n}\left(1 + \frac{1}{p}\right) = 25.86$$

$$S.E. = \sqrt{25.86} = 5.085$$

and for varieties not occuring in the same set,

$$V(t_{uvw} - t_{u'v'w'}) = \frac{2s^2}{3n}\left(1 + \frac{3}{2p}\right) = 26.78$$

$$S.E. = \sqrt{26.78} = 5.175$$

The average variance of all comparisons is

$$Vm = \frac{2s^2}{3n}\left(\frac{p + 2\frac{1}{2}}{p + 1}\right) = 26.59 \qquad S.E. = \sqrt{26.59} = 5.156$$

RESULTS.

The differences between the error variances are not great, and for general purposes of comparison the average variance may be used. Twice its standard error may be taken as a significant difference. Table II gives the list of the 169 varieties with their corrected mean yields arranged in order of descending magnitude and in groups of equality based on the significant difference of 10.312 ounces. Thus D 162 is significantly inferior to the varieties in group (1), and significantly superior to the remaining varieties except those in its own group (2). The significant difference represents 13.1 per cent. of the general mean yield.

There were two Demerara Creole selections, of which the better gave a yield of 81.153 ounces. Taking this as a standard of comparison, 83 varieties gave higher yields, of which 21 are significantly superior and 85 varieties gave lower yields, of which 27 are significantly inferior.

Greater interest centres in the 21 superior varieties. These comprise 13 local selections (9 prior to, and 4 made in, 1937), 4 imported varieties and 4 hybrids. Except for the 4 selections made in 1937, these varieties had been under progeny row test for three to six seasons, and had, with the exception of one, given superior average yields to Demerara Creole.

Of the 27 inferior varieties, 24 had given inferior average yields to Demerara Creole over three or more seasons, the other three had given yields about equal to this standard. With regard to the remaining varieties there has been the same general trend to follow the results of progeny row test over the last three or more seasons.

It would appear that one replicated experiment along the lines of the quasi-factorial arrangement has served to confirm the results of three or more seasons of progeny row testing. But further, this experiment has shown where varietal differences become significant and has pointed towards a few select varieties out of the great bulk, the behaviour of which can be followed up in additional testing.

Table II.

Corrected Mean Yields in ounces per plot of Varieties in Groups based on Significant Difference.

(1) 108.836—98.524

D99 (1)	108.836
71—37	105.870
D259	101.190
D99 (2)	100.086

(2) 98.316—88.004

D162	98.316
Karimganj (1)	97.781
D256	97.359
D257	96.863
Minalabon	96.822
Karimganj (2)	96.568
3—37	95.050
D222	94.761
D254	94.736
54—37	94.479
23—37	94.387
15—37	94.084
D238	93.514
20—37	93.213
D193	92.078
50—37	91.900
52—37	91.496
38—37	91.112
D255	90.923
39—37	90.887
SN3	90.864
18—37	90.427
A K Kulu	90.370
A16.34	89.799
70—37	89.615
16—37	89.455
56—37	89.398
D253	89.354
67—37	89.050
D258	88.962
53—37	88.721
55—37	88.483
D114	88.324
McK. Large (1)	88.227
42—37	88.099

(3) 87.754—77.442

Kalyaman (1)	87.754
63—37	87.644
19—37	87,327
D110 (1)	87.147
D183	86.971
51—37	86.787
14—37	86.733
D89	86.495
17—37	86.153
57—37	86.078
D110 (2)	86.069
43—37	86.038
SN7	85.962
Kalyaman (2)	85.550
D116 (2)	85.492
SN8	85.439
28—37	85.196
37—37	85.145
21—37	85.122
D97 B	84.822
McK. Small	84.686
SN 5	84.566
D247	84.326
40—37	84.326
D97 A	84.167
30—37	84.090
C 14.31	83.931
D92	83.869
41—37	83.633
65—37	83.348
Lead Rice	83.052
D205	83.048
McK. Large (2)	82.577
No. 79 (1)	82.272
68—37	82.047
Ramcajara (1)	81.896
D109 (1)	81.873
D116 (1)	81.830
D88	81.753
D250	81.660
69—37	81.584
58—37	81.381
8—37	81.344
D221 (2)	81.266
D297	81.257
D.C. (2)	81.153
D244	81.141
34—37	81.050
13—37	80.759

Table II.—(*Continued.*)

Corrected Mean Yields in ounces per plot of Varieties in Groups bases on Significant Difference.

No. 79 (2)	80.662
Ramcajara (2)	80.587
D108	79.702
D91 (2)	79.341
D94	79.166
61—37	79.142
66—37	79.006
D224	78.817
No. 76 (2)	78.763
32—37	78.461
Bamboo Rice	78.165
D135	78.059
B.S. (1)	77.955
26—37	77.774
44—37	77.766
D100	77.582
12—37	77.471

(4) 77.347—67.035

D243	77.347
60—37	76.622
59—37	76.596
29—37	76.353
62—37	76.159
N. Patna	76.040
D90	75.998
35—37	75.887
D246	75.816
SN 4	75.521
H7	75.354
D225 (1)	75.302
47—37	75.073
64—37	74.385
S	74.281
D91 (1)	74.154
D.C. (1)	73.977
D245	73.962
45—37	73.946
D242	73.862
31—37	73.612
Bommadeva	73.599
9—37 (2)	73.173
D160	73.160
D225 (2)	73.114
No. 75 (1)	73.050
25—37	72.909
Unity	72.716
SN2	71.964
P. Berbice	71.923
5—37 (2)	71.773
D221 (1)	71.349
33—37	71.312
46—37	71.121
D156	71.046
D188	70.886
D109 (2)	70.476
36—37	70.361
49—37	70.261
B.S. (2)	70.205
D239	69.841
24—37	69.793
No. 75 (2)	69.769
48—37	68.816
27—37	68.303

(5) 65 905—55.593

D184	65.905
9—37 (1)	64.793
SN 1	64.232
D251	63.785
4—37 (2)	63.765
D228	63.443
No. 76 (1)	63.302
4—37 (1)	61 685
D 95 (1)	60.488
D266	60.063
5—37 (1)	59.337

(6) 58 947 and below.

D236	58.947
Kao Bang Pra	48.925
D150	48.253
D261	43.027
D264	40.554
D263	37.144
D262	36.834
D267	5.767

Discussion.

In all experimental work, whenever a new method is to be tried out, the question is certain to be asked—"Is the new method more efficient?", and furthermore, if additional labour and computation are required, "Is the gain in efficiency large enough to compensate?" In the introduction it was stated that the method used to gauge the yielding power of varieties was by use of progeny rows, where no significant differences in yields can be estimated. The quasi-factorial method is designed to measure varietal differences statistically and because of this may be considered more efficient, although there is no gainsaying the value of progeny rows as observation plots.

However, the planting of 2-row plots in four or six groups as opposed to the progeny row planting of a single 10-row plot will usually involve more labour in planting and reaping. The last crop (quasi-factorial method) and the one before (progeny row planting) were approximately of the same magnitude, so that costs may be reasonably compared. Expenses for planting and reaping showed an increase of roughly about $11 per acre. There is also extra labour involved in the statistical calculations but not enough to offer any serious obstacle.

In considering the merits of the two systems, both the financial and time factors must be considered. The former system of progeny row planting meant that varieties had to be kept under observation for three or more seasons before some idea of their capabilities could be obtained. Even then, because of the absence of a satisfactory lay-out, the judgment was not sufficiently precise and a large number of varieties had, for safety, to be included in the replicated variety trials. On the other hand, one or two quasi-factorial trials will suffice for the selection of the really good varieties. This saving in time will more than offset the extra cost of the quasi-factorial trials and, in addition there will be a saving in the variety trials proper since fewer varieties will reach this stage.

The general conclusion may be reached that while progeny rows are very useful for acclimatising exotic, and purifying impure, varieties, the quasi-factorial method offers a more rapid and reliable means of testing a large number of varieties, and serves as a valuable preliminary to the full variety trials with their few select varieties.

Summary and Conclusions.

1. Attention is drawn to Yates' quasi-factorial layout as filling the need of the rice breeder for a method which will facilitate the early discards and selections among a large number of strains.

2. An experiment where the method was used for testing 169 varieties is described, and it is shown that differences of 13 per cent. in yield can be measured. It is further shown that the results of the experiment are in good agreement with the average data from three seasons' tests in progeny rows.

3. The merits of the quasi-factorial layout, in comparison with accumulating data from progeny row plots are discussed and it is pointed out that although the former involves 14 per cent. increase in field costs and more statistical computa-

tion, it proves cheaper in the long run since a variety can be judged more quickly and it is possible to reduce, to a minimum, the number of varieties to be dealt with in the replicated variety trials.

ACKNOWLEDGMENTS.

Thanks are due to Mr. C. H. B. Williams, Sugar Agronomist and Plant Breeder, for his suggestions regarding this experiment and the presentation of its results, and to F. O. Ramotar of the Rice Experiment Station for his assistance in the conduct of the experiment.

REFERENCES.

1. YATES, F. A new method of arranging variety trials involving a large number of varieties. Jour. Agric. Science, 26 : 424-455. 1936.

2. ——— The design and analysis of factorial experiments. Imperial Bureau of Soil Science, Technical Communication No. 35.

3. GOULDEN, C. H. Modern methods for testing a large number of varieties. Dominion of Canada Dept. of Agriculture, Publication 575, Technical Bull. 9. 1937.

DOUBLE VERSUS SINGLE PLANTING OF SUGAR CANE.

BY

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The opinions of British Guiana planters vary considerably as to the amount of planting material to be used in a row and its ideal disposition (single line, staggered, double line, etc.), and the feeling is strongly held by some that single planting produces less but bigger stalks whose size more than counter-balances the weight of the larger number of thinner stalks obtained from double planting. The thicker stalks, it is often claimed, are a better commercial proposition, being cheaper to cut and load.

To throw some light on the problem an experiment was started at the Sugar Experiment Station (Sophia) and the present paper gives the results secured from the plant canes and first ratoons. It is thus an extension of the report on the plant cane results made to the Sixth Congress of the International Society of Sugar Cane Technologists.

THE EXPERIMENT.

Twenty-one pairs of plots were planted to P.O.J.2878, seven pairs in each of three different fields. It was felt that by spreading the test over three fields, planted and harvested on different dates, more confidence could be placed in the general applicability of any conclusions drawn. Each plot consisted of six rows and comprised an area of 0.02548 acre. One plot of each pair was planted double-row with twice the number of cuttings used to plant its mate single-row. In the single planting 36 cuttings were used to a row. The average weight of a cutting was 0.48 lb., its average length 15.3 inches. At these rates it may be assumed that single planting would involve just under two and double planting a little under four tons of material per acre, the excess required by double planting under the conditions of this test being 1.82 tons per acre. The plots of each pair were contiguous along the same bed but the order of the two plots in each pair was determined by chance. The significance of the differences obtained was tested by Fisher's modification of Student's method for comparing pairs of observations.

The numbers of the fields and the dates on which they were planted and harvested are listed below :—

Field.	*Planted.*	*Harvested.*	*Age at Harvest, Months.*	*Harvested.*	*Age at Harvest, Months.*
15 East	19.12.36	3.3.38	14.50	27.4.39	13.75
13 East	23. 1.37	26.2.38	13.00	28.2.39	12.00
13 West	25. 2.37	9.3.38	12.50	26.4.39	13.50

Rains were abnormally high during the wet seasons and unusually low during the dry seasons in which these canes were growing as plants (see Table I) and the unusual weather conditions appear to have depressed the yields. The first ratoon yields were also adversely affected by six months of continuous heavy rains following the harvest of the plant canes.

TABLE I.

Rainfall at Sophia Sugar Experiment Station.

Month.	Rainfall, 1936—39, Inches.	Average Rainfall, 1921—38, Inches.	Excess or Deficit during Growth of the Experiments.
December 1936 ...	23.04	14.17	8.87
January 1937 ...	14 63	9.18	5.45
February	0.75	4.27	– 3.52
March	1.53	4.78	– 3.25
April	5.19	5,46	– 0.27
May	13.09	11.77	1.32
June	19.95	14.37	5.58
July	19.70	11.26	8.44
August	8.23	8.54	– 0.31
September ...	2.61	2.68	– 0.07
October	4.57	3 95	0.62
November	3.60	5.63	– 2.03
December	12.76	14.17	– 1.41
January 1938 ...	13.72	9.18	4.54
February	14.20	4.27	9.93
March	14.76	4.78	9.98
April	8.94	5.46	3.48
May	11.14	11.77	– 0.63
June	12.99	14.37	– 1.38
July	12.86	11.26	1.60
August	15.92	8.54	7.38
September ...	2.42	2.68	– 0.26
October	3.37	3.95	– 0.58
November	5.29	5.63	– 0.34
December	7.71	14.17	– 6.46
January 1939 ...	12.25	9 18	3.07
February	4.11	4.27	– 0.16
March	4.78	4.78	—
April	8.74	5.46	3.28

The topsoils of these fields are acid silts overlying alkaline silt subsoils. The topsoils are rather low in organic matter while in the subsoils the carbon: nitrogen ratios of the organic matter are wide.

For the plant canes, five weeks after planting, a plot by plot check was made of the number of shoots (denoted arbitrarily first order shoots) and

each was labelled with a metal tag. Five weeks later another check was made and all new shoots (denoted arbitrarily second order shoots) were labelled with a differently shaped tag. At harvest only millable stalks were considered and it was determined how many out of the total for each plot were 'first order', how many 'second order', and how many were 'late shoots', as all shoots developing after ten weeks were arbitrarily called.

Each group of stalks in each plot was weighed separately and, since the number of stalks present was known, it was possible to calculate the average weight per stalk. Further, from each group of stalks in each plot, fourteen average canes were measured and sent in as a sample to be passed through a power-driven experimental mill for purposes of analysis.

For the first ratoons, only the weight of cane and number of stalks were determined, and a sample from each plot crushed for analysis. Consequently none of the data recorded in Table III is available for the first ratoons.

Results and Discussion.

Stalk Population.

Table II shows, for single and double planting separately, the number of first and second order shoots at the start of the experiment and the number of these present as millable stalks at harvest; also the number of late shoots present at harvest. The differences in favour of double planting are also recorded and marked with an asterisk when statistically significant.

At all stages, in the plants, the double planting gave a greater number of stalks than the single. There was a considerable mortality among the early shoots and, as shown more clearly in Table III, it was heavier in the double planting than in the single but not sufficiently so to offset the much higher population of the double-planted area. It may be said that the higher mortality used up just less than half of the initial advantage of the double-planted plots.

In the first ratoons the comparison was made only on millable stalks at harvest. Here again the double planting proved superior.

TABLE II.

Comparison of the Number of Stalks per Acre Produced from Single and Double Plantings.

	Young Shoots				Millable Cane at Reaping							
	First order (after 5 weeks)		Second order (after 10 weeks)		First order		Second order		Late		Total	
	Single Planting	Double Planting	Single Planting	Double Planting	Single Planting	Double Planting	Single Planting	Double Planting	Single Planting	Double Planting	Single Planting	Double Planting
No. of Shoots Plants 1st Ratoons	7,417	14,540	11,158	17,590	2,888	4,533	3,587	4,764	15,545	16,543	22,020 21,877	25,840 24,278
Difference in favour of Double Planting Plants 1st Ratoons	7,123*		6,432*		1,645*		1,177*		998*		3,820* 2,401*	
% Increase of Double on Single Planting Plants 1st Ratoons	96.04		57.61		56.96		32.81		6.42		17.35 10.97	

*Difference Significant.

Table III shows what percentage of first and second order plant cane shoots lived through to harvest and the numerical composition of the crop in terms of various orders.

TABLE III.

Fate of First and Second Order Shoots and Numerical Composition of crop by Shoots of Different Orders.

Treatment.	% First Order Shoots present at		% Second Order Shoots present at		% Composition of Harvest.		
	5 weeks.	Harvest	10 weeks.	Harvest.	First order shoots.	Second order shoots.	Late shoots.
Single Planting	100.00	38.93	100.00	32.14	13.11	16.29	70.60
Double ,,	100.00	31.18	100.00	27.08	17.54	18.44	64.02

It will be seen that about two-thirds of the first order and a like portion of the second order shoots disappeared before the cane was harvested and that mortality was higher when planting was double than when it was single. The differences in this respect are statistically significant. On the other hand, the

first and second order shoots formed 36 per cent. of the final crop in the case of the double planting against under 30 per cent. for the single planting.

The population appears to have been about normal for P.O.J. 2878 in this Colony, comparing favourably with other counts made at various times and places. This is brought out in Table IV below, where counts for the two other standard canes are included for comparison.

TABLE IV.

Number of Stalks per Acre at or near Harvest in British Guiana.

Variety.	This Investigation.	Ressouvenir, 1937.	Rose Hall, 1937.	Port Mourant, 1937.	(1) Sophia, (Cooper, 1937).	(2) Various Sites (Cleare, 1938).	(3) Rose Hall, (Falconer, 1938).
P.O.J. 2878							
Plants	23,930	...	23,716	26,264	20,377	...	23,800
1st Ratoons	23,077						
Diamond 10	...	...	...	...	17,271	17,532	...
D. 625	...	15,304	.	...	10,823	13,785	.

(1) *Agric. Jnl. of British Guiana*, VIII, No. 1, pp. 4–40.
(2) „ „ „ „ „ VIII, „ 2, „ 63–83.
(3) Private Communication.

Weight Composition of Crop.

The weight composition of the crop, in terms of various types of stalks, is shown in Table V.

TABLE V.

Percentage Composition of Crop by Weight in Relation to Shoots of Different Orders.

	First Order		Second Order		Late Shoots		Total	
	Single Planting.	Double Planting.	Single Planting.	Double Planting	Single Planting.	Double Planting.	Single Planting.	Double Planting.
Weight of Cane per Acre, Tons.								
Plants	2.63	4.15	3.66	4.78	17.20	17.61	23.49	26.54
1st Ratoons.							17.33	19.41
% of Total, Plants:	11.20	15.64	15.58	18.01	73.22	66.35	100.00	100.00

Double planting gave a total tonnage of cane 12.98 per cent. higher than single planting in the plants, and 12.00 per cent. higher in the first ratoons; in both instances the increment was statistically significant. In the plants, as

might have been expected, the increment was secured mainly in the first five weeks of growth and, to a lesser extent, in the second five weeks. The higher mortality in the double-planted plots was not sufficient to offset the marked superiority of these plots in number of stalks per acre. The tonnage of late stalks was practically identical for the two types of planting, although, in this category, the double planting averaged 998 stalks per acre more (see Table II) than the single.

In Table VI certain other effects of the two types of planting are compared.

TABLE VI.

Comparison of the Effects of Single and Double Planting on the Purity, Sucrose in Cane %, Glucose Ratio and Length and Weight per Stalk.

	First Order Shoots			Second Order Shoots			Late Shoots		
	Single Planting	Double Planting	Difference	Single Planting	Double Planting	Difference	Single Planting	Double Planting	Difference
Purity									
Plants :	85.6	86.3	−.7	86.3	86.1	.2	85.2	85.5	−.3
1st Ratoons :							90.6 **	90.9**	−.3**
Sucrose in Cane %									
Plants :	13.45	13.47	−.02	13 76	13.65	.11	13 56	13.75	−.19
1st Ratoons :							15 64**	15.92**	−.28**
Glucose Ratio,									
Plants :	6 68	6.28	.40	6.12	6.43	−.31	6.92	7 54	−.62
1st Ratoons :							5.78**	5 29**	.49**
Length per Stalk, ins.									
Plants :	73	76	− 3	77	80	−3	79	83	−4 *
Weight per Stalk, lb.									
Plants :	2.10	2 04	.06	2.31	2.31	—	2.57	2.45	.12
1st Ratoons :							1.77**	1.79**	−.02**

It will be seen that in neither crop had the single and double planting any statistically significant differential effects on the juice purity, the sucrose content of the cane, the glucose ratio or the weight per stalk. In the case of length per stalk of the plant canes, the double planting tended to produce longer first and second order stalks, and in the late stalks the difference in favour of double planting was statistically significant.

SUMMARY.

A comparison of single versus double planting was made with P.O.J.2878 on acid silt overlying alkaline silt subsoil on the low-lying coastal belt of British Guiana. It was found that:

1. In plant canes, double planting produced significantly more shoots per acre in the first five weeks and the second five weeks;

*Difference Significant.

**The stalks of the first ratoon population were not separated as regards order of appearance. The data presented under 'late shoots' for this crop are for all millable stalks of the plots.

2. At harvest double planting yielded significantly more millable stalks both in plants and ratoons;

3. In the plant canes, mortality was higher among the double-planted than among the single-planted population, but insufficiently so to affect the great initial advantage of the former since it used up just less than half of it;

4. Two-thirds of the first order (0—5 weeks) and a like number of the second order (6—10 weeks) shoots perished before the plant cane harvest and the two groups together formed only 30 to 36 per cent. of the whole harvest;

5. Double planting, using less than two tons of extra planting material per acre, gave a significant increase of 12.98 per cent. in the yield of plant cane and 12.00 per cent. in the yield of first ratoon cane (a further advantage is a much better stand at the start and the almost total elimination of the expense of supplying blanks);

6. No significant differences were observed between the weights of cane per stalk, the sucrose contents of the cane, the juice purities or the glucose ratios from single as against double planting, but the latter produced significantly longer late (after 10 weeks) stalks as plants.

CATALOGUE OF THE LEPIDOPTERA RHOPALOCERA (BUTTERFLIES) OF BRITISH GUIANA—*(Contd.)*

BY

ARTHUR HALL, F.R.Ent.S.

145. PYRAMEIS CARDUI.

Papilio cardui, Linnaeus, Faun. Snec. p. 276, n. 1054 (1761).

I took this cosmopolitan and migratory species at Bartica but it is at present a rarity in South America.

146. PYRAMEIS MYRINNA.

P. myrinna, Doubleday, Gen. Diurn. Lep. p. 203, n. 9 (1849).

In the British Museum from Mt. Roraima.

147. PRECIS LAVINIA.

Papilio lavinia, Cramer, Pap. I, t. 21, C, D (1775).

Generally distributed and common in open weedy places. It is very variable and a number of forms of no local constancy have been named. The form most prevalent in British Guiana, at any rate near Georgetown, is *evarete* Cramer which has no blue gloss on the hind wings.

148. ANARTIA JATROPHAE.

Papilio jatrophae, Linnaeus, Mus. Ulr. p. 269 (1764).

One of the commonest butterflies nearly everywhere, preferring dry spots and open fields. Although so abundant nothing seems to be known of its early stages.

149. ANARTIA AMATHEA.

Papilio amathea, Linnaeus, Syst. Nat. I, p. 478, n. 118 (1758).

Generally distributed and common. Unlike *A. jatrophae* it is partial to damp places such as the borders of trenches by the roadside.

150. EUNICA SOPHONISBA.

Papilio sophonisba, Cramer, Pap. Ex. IV, t. 295, A, B (1782).

Demerara River; Tumatumari; Potaro Road; Barima River. Always rare and solitary. I have specimens dated March, July and August.

151. EUNICA AMELIA.

Papilio amelia, Cramer, Pap. Ex. II, t. 136, B, C (1779).

Singly from the Mazaruni and Potaro Rivers but always very scarce.

152. EUNICA VIOLA.

E. viola, Bates, Journ. Ent. II, p. 199, n. 34, t. 9, f. 4 (1864).

Carimang River. Also a female in my collection from "British Guiana" collected by R. Haensch.

153. EUNICA ORPHISE.

Papilio orphise, Cramer, Pap. Ex. I, t. 42, E, F (1776).

A female from Omai in the British Museum; Berbice River (Coll. Ent. Div.)

154. EUNICA ANNA.

Papilio anna, Cramer, Pap. Ex. III, t. 281, A, B (1782).

I have a single female of this species from Friendship on the Berbice River (H. C. Patoir).

155. EUNICA MONINIA.

Papilio moninia, Cramer, Pap. Ex. IV, t. 387, F, G (1782).

In the British Museum from Demerara.

156. EUNICA MALVINA.

E. malvina, Bates, Journ. Ent. II, p. 195, n. 21, t. 9, f. 2, 2a (1864).

Omai; Carimang River.

157. PERIA LAMIS.

Papilio lamis, Cramer, Pap. Ex. III, t. 238, E (1782).

Bartica; Carimang River. Rather rare.

158. TEMERIS LAOTHOE.

Papilio laothoe, Cramer, Pap. Ex. II, t. 132, A, B (1779).

Demerara River; Friendship on the Berbice; Bartica; Omai; Kaieteur Falls; Mabaruma. Not very common although widely distributed.

159. CATONEPHELE ACONTIUS.

Papilio acontius, Linnaeus, Mant. Plant. p. 537 (1771).

Bartica; Kaieteur Falls; Mabaruma. Not rare in forest districts.

160. CATONEPHELE NUMILIA.

Papilio numilia, Cramer, Pap. Ex. II, t. 81, E, F (1779).

A female from "British Guiana" in the British Museum.

161. NESSAEA OBRINUS.

Papilio obrinus, Linnaeus, Syst. Nat. I, p. 470, n. 78 (1758).

Demerara River; Parika; Berbice. Rather common at Parika from December to February, flying in deep shade but settling on leaves where a spot of sunshine breaks through.

162. NESSAEA BATESII.

Epicalia batesii, Felder, Wien. Ent. Mon. IV, p. 237, t. 3, f. 3, (1860).

Demerara; Carimang River, Kuturi Sources. Much rarer than the preceding species.

163. DYNAMINE ATHEMON.

Papilio athemon, Linnaeus, Syst. Nat. I, p. 484, n. 157 (1758).

Demerara River; Omai.

164. DYNAMINE DECIMA.

Eubagis decima, Hewitson, Ex. Butt. I, *Eubagis* t. 1, f. 4-6 (1852).

A female from the Carimang River has the white markings greatly reduced as compared with typical specimens from the Lower Amazon and may represent a new race.

165. DYNAMINE ONIAS.

Eubagis onias, Hewitson, Ex. Butt. II, *Eubagis* t. 2, f. 13-15 (1857).

A single female from "British Guiana" (Parish) in the British Museum.

166. DYNAMINE RACIDULA.
Eubagis racidula, Hewitson, Ex. Butt. I, *Eubagis* t. 1, f. 2, 3 (1852).
Potaro River; Kaieteur Falls.

167. DYNAMINE MYLITTA.
Papilio mylitta, Cramer, Pap. Ex. III, t. 253, D, E (1782).
The commonest species of the genus. Parika; Omai; Quonga. Probably to be found in most forest localities.

168. CALLICORE CLYMENA.
Papilio clymena, Cramer, Pap. Ex. I, t. 24, E, F (1775).
Quonga; Mabaruma; Mt. Roraima; Kuturi River; Upper Corentyne. Apparently rare in the Guianas although often abundant in other parts of South America.

169. CATAGRAMMA IDAS.
Papilio idas, Müller, Natursystem, I, p. 633, t. 19, f. 11 (1774).
One of the rarest butterflies of the Colony. There is a damaged female in the Georgetown Museum and I have seen two or three specimens from British Guiana but none with any definite localities. Further information about the species would be welcome. Two females from Demerara (Castell) in the British Museum.

170. CATAGRAMMA ASTARTE.
Papilio astarte, Cramer, Pap. Ex. III, t. 256, C, D (1782).
A male in the British Museum from Friendship, Berbice River, and a female from "British Guiana".

171. CATAGRAMMA CYNOSURA AMAZONA.
C. amazona, Bates, Jour. Ent. II. p. 209 n. 59, t. 10, f. 5, 5a (1864).
A pair from the Kaieteur Falls (A. Hall) is the only record so far.

172. CALLITHEA LEPRIEURII.
C. leprieurii, Feisthamel, Rev. Zool. 1835, t. 122.
Mr. W. J. Kaye saw this species near Bartica but was unable to capture it.

173. GYNAECIA DIRCE.
Papilio dirce, Linnaeus, Syst. Nat. I, p. 477, n. 117 (1758).
Common in many wooded places, settling on tree trunks with the wings closed. The early stages are wellknown, the larva feeding upon Cassia.

174. CALLIZONA ACESTA.
Papilio acesta, Linnaeus, Syst. Nat. I, p. 479, n. 127 (1758).
Annai; Berbice; Upper Real; Mabaruma. Similar in habits to *Gynaecia dirce* but much rarer.

175. HAEMATERA PYRAMUS THYSBE.
H. thysbe, Doubleday & Hewitson, Gen. Diurn. Lep. t. 30, f. 4 (1848).
In the British Museum from Quonga (H. Whitley).

176. AGERONIA FEBRUA.
A. februa. Hübner, Samml. Ex. Schmett. (1816-24).
Fairly common in wooded places.

177. AGERONIA FERONIA.

Papilio feronia, Linnaeus, Syst. Nat. I, p. 473, n. 95 (1758).

Common and generally distributed. Like all species of the genus it settles upon tree trunks with expanded wings. It makes a loud clicking sound when flying.

178. AGERONIA AMPHINOME.

Papilio amphinome, Linnaeus, Syst. Nat. I, (2), p. 779, n. 176 (1767).

Not rare at Parika.

179. AGERONIA ARINOME.

Peridromia arinome, Lucas, Rev. Zool. 1853, p. 312.

Kuturi Sources (G. A. Hudson, Jan.-Feb. 1936); Demerara River; Groete Creek, R. Essequibo (G. Brinsley in Coll. Ent. Div.)

180. ECTIMA IONA.

E. iona, Hewitson, Gen. Diurn. Lep., t. 42, f. 4 (1849).

Annai; Potaro Road; Mabaruma. Always a rare species. Like the Ageroniae it settles on tree trunks with the wings expanded.

181. DIDONIS BIBLIS.

Papilio biblis, Fabricius, Syst. Ent. p. 505, n. 261 (1775).

Omai. Apparently rare in the Guianas.

182. CYSTINEURA CANA.

C. cana, Erichson, Schomb. Reisen III, p. 599 (1848).

Annai; Quonga.

183. VILA EMILIA.

Papilio emilia, Cramer, Pap. Ex. III, t. 223, E, F (1782).

King Frederick William Falls on the Corentyne (G. A. Hudson).

184. PYRRHOGYRA NEAEREA.

Papilio neaerea, Linnaeus, Syst. Nat. I, p. 479, n. 126 (1758).

Demerara River; Parika; Mabaruma (Hall) in Coll. Ent. Div. In the form *reducta* Hall from Parika (and French Guiana) the white bands are only half the normal width and ab. *melanotica* Talbot is a unique abberration from British Guiana having the bands nearly obsolete.

185. PYRRHOGYRA CRAMERI.

P. crameri, Aurivillius, Kong. Svensk. Vet. Akad. Handl. IX, p. 98.

Parika; Mabaruma. Not uncommon where found.

186. PYRRHOGYRA STRATONICUS.

P. stratonicus, Fruhstorfer, Stett. Ent. Zeit. 1908, p. 36.

I took a female of this species at Mabaruma in January 1930. As the only other known specimens have come from the Peru-Bolivian frontier its existence in British Guiana is a little surprising.

187. MEGALURA CHIRON.

Papilio chiron, Fabricius, Syst. Ent. p. 452, n. 40 (1775).

Upper Corentyne River (G. A. Hudson); "British Guiana" in the British Museum. An abundant species in most parts of South America.

188. MEGALURA ORSILOCHUS.

Papilio orsilochus, Fabricius, Gen. Ins. p. 252 (1777).

Annai; Carimang River; Kaieteur Falls; Mabaruma. A very graceful species on the wing and never common.

189. MEGALURA PELEUS.

Papilio peleus, Sulzer, Gesch. Ins., t. 13, f. 4 (1776).

Berbice.

190. HYPOLIMNAS MISIPPUS.

Papilio misippus, Linnaeus, Mus. Ulr. p. 264 (1764).

This East Indian species is a recent introduction into South America. It is to be found at Parika, Mabaruma and other places in the Colony.

191. VICTORINA STENELES.

Papilio steneles, Linnaeus, Syst. Nat. I, p. 465, n. 124 (1758).

Generally common and often abundant.

192. ADELPHA MESENTINA.

Papilio mesentina, Cramer, Pap. Ex. II, t. 162, B, C (1779).

Annai.

193. ADELPHA TIZONA KAYEI.

A. tizona kayei subsp. nov.

Description.—Differs from all the described forms of *A. tizona* Feld. In the fore wings having three large subapical spots completely united with one another and with the oblique discal band, giving the latter the appearance of being forked. It has a superficial resemblance to *A. ximena* Feld. Potaro River. Type, a female in the collection of W. J. Kaye.

194. ADELPHA COCALA.

Papilio cocala, Cramer, Pap. Ex. III, t. 242, F, G. (1782).

Demerara River; Annai; Omai; Carimang River; Mabaruma.

195. ADELPHA PSEUDOCOCALA.

A. pseudococala, Hall, Nov. Zool. XXXIX, p. 10 (1933).

Mabaruma; Kaieteur Falls. This species is difficult to distinguish from *A. cocala* but the Rev. Miles Moss has bred it at Para from totally different larvae and pupae.

196. ADELPHA EROTIA.

Heterochroa erotia, Hewitson, Ann. Mag. Nat. Hist. XX, p. 259, t. 20, f. 3 (1847).

I took a single very typical specimen at Mabaruma.

197. ADELPHA THESPROTIA.

Heterochroa thesprotia, Felder, Reise Nov. Lep. III, p. 419, n. 653 (1867).

Berbice; Takutu; Oronoque-New River confluence (G. A. Hudson).

198. ADELPHA DELPHICOLA.

A. delphicola, Fruhstorfer, Koch-Grunberg's Reise II, p. 348.

A specimen in my collection from Friendship on the Berbice River (H. C. Patoir).

199. ADELPHA PHLIASSA.

Nymphalis phliassa, Godart, Enc. Meth. IX, p. 373, n. 78 (1823).

Annai; Berbice; Ida Sabina.

200. ADELPHA CYTHEREA.

Papilio cytherea, Linnaeus, Syst. Nat. I, p. 481, n. 139 (1758).

The commonest species of the genus, usually in damp spots near second growth forest.

201. ADELPHA IPHICLUS.

Papilio iphiclus, Linnaeus, Syst. Nat. I, p. 486, n. 172 (1758).

Demerara River, Mabaruma.

202. ADELPHA MELONA.

Heterochroa melona, Hewitson, Ann. Mag. Nat. Hist. XX, p. 258, t. 20, f. 2 (1847).

Bartica; Mabaruma; Carimang River. A fairly common species in forests.

203. ADELPHA SERPA.

Heterochroa serpa, Boisduval, Spec. Gen. I, t. 8, f. 4 (1836).

In the British Museum from the Carimang River.

204. ADELPHA PARAENA.

Heterochroa paraena, Bates, Journ. Ent. II, p. 331, n. 167 (1865).

A female in my collection from "British Guiana" (Parish).

205. CHLORIPPE AGATHINA.

Papilio agathina, Cramer, Pap. Ex. II, t. 167, E, F (1782).

Quonga; Omai; King Frederick William Falls; Upper Corentyne.

206. HISTORIS ODIUS.

Papilio odius, Fabricius, Syst. Ent. p. 457, n. 60 (1775).

Parika; Omai. Not uncommon.

207. COEA ACHERONTA.

Papilio acheronta, Fabricius, Syst. Ent. p. 501, n. 249 (1775).

Taken by J. G. Myers on the Rupununi Savannahs (Nov. 1933).

208. PREPONA DEMOPHON.

Papilio demophon, Linnaeus, Syst. Nat. I, p. 464, n. 36 (1758).

Omai; Parika; Bartica, Mabaruma; Berbice (Coll. Ent. Div.) Fairly common and easily attracted to sugar on tree trunks.

209. PREPONA MEANDER.

Papilio meander, Cramer, Pap. Ex. I, t. 12,A, B (1775).

Carimang River.

210. PREPONA PHERIDAMAS.

Papilio pheridamas, Cramer, Pap. Ex. II, t. 158, A, B (1779).

In the British Museum from Omai.

211. PREPONA ANTIMACHE.

Morpho antimache, Hübner, Verz. Bek. Schmett. p. 49 n. 458 (1816).

There are specimens in the Georgetown Museum without definite locality.

212. PREPONA DEXAMENES.

P. dexamenes, Hoppfer, Stett. Ent. Zeit. 1874, p. 352, n. 54.

A male from Demerara in the British Museum.

213. PREPONA OMPHALE.

Morpho omphale, Hübner, Verz. bek. Schmett. p. 49, n. 454 (1816).

Represented in the Georgetown Museum but with no indication as to whence the specimens came. There is no reason, however, to doubt its existence in the Colony.

214. AGRIAS CLAUDIA.

Papilio claudia, Schulz, Naturf. IX, p. 100, t. 2 (1776).

This fine species is extremely rare and its headquarters in British Guiana are not definitely known. There are two or three specimens in the Georgetown Museum believed to have come from the Demerara River or Berbice and a dark aberration called *infernalis* Fruhstorfer is said to have come from New Amsterdam but I have not seen an authentic British Guiana specimen in any English collection.

215. MEGISTANIS BAEOTUS.

M. baeotus, Doubleday & Hewitson, Gen. Diurn. Lep. t. 48, f. 2 (1850).

Upper Kuturi River (G. A. Hudson).

216. MEGISTANIS JAPETUS.

M. japetus, Standinger, Ex. Tagf. I, p. 174, t. 60 (1888).

Oronoque River, near the Brazilian frontier. The hitherto undescribed female of this species has the bands of the upperside yellow instead of blue.

217. ANAEA HELIE.

Papilio helie, Linnaeus, Syst. Nat. I, p. 475, n. 103 (1758).

Marudi Mountain, Rupununi District (L. H. J. Ashburner). This species is probably better known under the name of *A. ryphea*, Cramer.

218. ANAEA ERIBOTES.

Papilio eribotes, Fabricius, Syst. Ent. p. 484, n. 183 (1775).

Demerara River; Kaieteur Falls.

219. ANAEA LEONIDA.

Papilio leonida, Cramer, Pap. Ex. IV, t. 388, C, D (1782).

An old specimen in my collection is labelled "Georgetown". If this is correct it was probably collected before the bush had been cleared from the vicinity. It is a fairly well known species in Dutch and French Guiana.

220. ANAEA PITHYUSA MORENA.

A. pithyusa morena Hall, "Entomologist" LXVIII, p. 224 (1935).

Mabaruma; Kuturi River; Upper Corentyne. It is a little strange that nearly all the specimens of this race which come to hand are females whereas in the typical race from Central America the males are far more abundant.

221. ANAEA GLAUCE.

Nymphalis glauce, Felder, Wien. Ent. Mon. VI, p. 119, n. 132 (1862).

Kaieteur Falls. (March 1936, A. Hall).

222. ANAEA MORVUS.

Papilio morvus, Fabricius, Syst. Ent. p. 484, n. 184 (1775).

Carimang River; Bartica; Mabaruma; Mt. Roraima. Usually the commonest species of the genus.

223. ANAEA BASILEA.

Papilio basilea, Cramer, Pap. Ex. IV, t. 329, E, F. (1782).

Kuturi Sources (G. A. Hudson, Jan.-Feb. 1936).

224. ANAEA ODILIA.

Papilio odilia, Cramer, Pap. Ex. IV, t. 329, C, D (1782).

In my collection from Friendship on the Berbice.

225. HYPNA CLYTEMNESTRA.

Papilio clytemnestra, Cramer, Pap. Ex. II, t. 137, A, B (1779).

Annai; Takutu; Kaieteur Falls; Kuturi River. Most British Guiana specimens belong to the rare typical form in which the fore-wings have no subapical spots.

226. ZARETES ISIDORA.

Papilio isidora, Cramer, Pap. Ex. III, t. 235, A, B, E, F (1782).

Parika. As this is a common species in neighbouring countries it is probably to be found elsewhere if looked for.

227. SIDERONE MARTHESIA.

Papilio marthesia, Cramer, Pap. Ex. II, t. 191, A, B (1779).

Potaro River (coll. W. J. Kaye). The older name of this fine species is probably *S. galanthis* Cramer but the figure of the latter is sufficiently poor to be a little doubtful.

228. PROTOGONIUS HIPPONA.

Papilio hippona, Fabricius, Gen. Ins. p. 265 (1775).

Omai, Berbice; Parika; Mabaruma.

229. LIBYTHEA CARINENTA.

Papilio carinenta, Cramer, Pap. Ex. II, t. 108, E, F (1779).

Potaro River (W. J. Kaye). This particular genus probably belongs to the *Nymphalidae* and not to the *Erycinidae*.

Family ERYCINIDAE.

One of the peculiarities of this family is that many species only occur singly. A specimen of a certain species may be taken at a particular spot and no others may be found there again for a long period. For this reason many of our records are taken from single specimens. A few species are common and are notable for their habit of settling on the under surface of leaves with the wings expanded flat, so that they seem to suddenly disappear from the sight of the observer.

Sub-family EUSELASIINAE.

230. EUSELASIA UZITA.
Eurygona uzita, Hewitson, Ex. Butt. II, *Eurygona* t. 2, f. 12, 13 (1852).
Annai. Apparently locally common.

231. EUSELASIA MYS.
Eurygona mys, Herrich-Schaeffer, Ex. Schmett. f. 37, 38 (1835).
Quonga; Mt. Roraima.

232. EUSELASIA EUCRITUS.
Eurygona eucritus, Hewitson, Ex. Butt. II, *Eurygona* t. 2, f. 14-16 (1852).
Carimang River.

233. EUSELASIA ZENA.
Eurygona zena, Hewitson, Ex. Butt. II, *Eurygona* t. 8, f. 74, 76 (1860).
Upper Cuyuni River (J. G. Myers). The single specimen, a female, has the red spot on the hind wings much smaller than in the typical form and may represent a new race.

234. EUSELASIA EUBOTES.
Eurygona eubotes, Hewitson, Ex. Butt. I, *Eurygona*, t. 7, f. 64 (1856).
Annai.

235. EUSELASIA EUTYCHUS.
Eurygona eutychus, Hewitson, Ex. Butt. I, *Eurygona* t. 5. f. 44-46. (1856).
Kuturi River.

236. EUSELASIA MELAPHAEA.
Erythia melaphaea, Hübner, Zutr. Ex. Schmett. f. 209, 210 (1823).
Kaieteur Falls; Carimang River.

237. EUSELASIA ORFITA.
Papilio orfita, Cramer, Pap. Ex. II, t. 112, F (1779).
Annai; Carimang River; Mabaruma.

238. EUSELASIA EULIONE.
Eurygona eulione, Hewitson, Ex. Butt. I, *Eurygona* t. 6, f. 52 (1856).
Potaro River.

239. EUSELASIA CAFUSA
Eurygona cafusa, Bates, Journ. Linn. Soc. IX, p. 422, n. 23 (1868).
Annai.

240. EUSELASIA EUSTACHIUS LICINIA.
Eurygona licinia, Godman, Trans. Ent. Soc. 1903, p. 531, t. 20, f. 6.
Type in the British Museum from Mt. Roraima.

241. EUSELASIA UTICA.
Eurygona utica, Hewitson, Ex. Butt. I, *Eurygona*, t. 3, f. 29-31 (1854).
Annai.

[*To be Continued*]

NOTES.

The Foreshore Vegetation east of Georgetown. Since the last notes on the subject appeared in this Journal (VII, p. 191, 1936) further interesting changes have taken place in the configuration of the shore line, which have been reflected in the vegetation behind it.

A high caddy beach has been formed by wind and wave action at the seaward edge of the courida belt from Bel Air to La Bonne Intention, and extends westwards as far as Kitty groyne. The back of this beach (*i e.*, the landward side) is forming a new shore line, and is only covered by spring tides. This means that the original muddy foreshore between the new beach and the Sea Wall, the area which has been carrying Courida (*Avicennia nitida*) and Rice Grass (*Spartina brasiliensis*) in recent years, is now left dry between spring tides, except for a few small areas covered by water coming in through natural drainage channels that pass out through the beach at intervals. In this area considerable changes in the vegetation are taking place and both the Courida and the Spartina are dying out.

We may refer to the Courida first, as the loss of this has been more noticeable. In former published notes on the foreshore vegetation, reference has been made to the "Mangrove Belt" to denote the belt of trees growing on the muddy foreshore. This belt includes, besides *Avicennia*, a certain amount of *Laguncularia racemosa* and occasional trees of *Rhizophora* spp., but as in the locality under discussion the *Avicennia* is entirely dominant, the tree belt will be referred to here as 'Courida'.

In 1934 a thick belt of Courida, which had grown up within the previous few years, extended from Ogle Koker trench to Liliendaal, and appeared to be stretching on towards Kitty. As was pointed out in the last Notes, a portion of this belt of trees was almost entirely cut down in 1934, the part cleared extending from a line opposite the east end of the promenade backing the sea wall at Turkeyen to the western fringe of the Courida opposite Bel Air Hotel. From Turkeyen east-ward to Ogle Koker however the trees remained. It is first of all interesting to note that the expanse of bare mud left by this clearance, and described in the previous Notes, is today still bare with the exception of a few widely scattered and very small clumps of Spartina and some struggling Courida seedlings, both of which occur in depressions or on the edge of drainage channels.

In 1936, however, it became noticeable that the trees near the wall in the remaining portion of the Courida belt, in front and to the east of Turkeyen, were beginning to die, starting from the west end of the belt. During 1937, this became more marked, and in 1938 the whole belt nearly as far as Ogle Koker died

out, with the exception of a narrow margin of healthy trees on the seaward side, immediately behind the recently formed beach. (Plate II, Fig. 1) which should be compared with Plate II, Fig. 2, *loc. cit.*).

On walking out over the mud flat beside the belt of dead trees, the mud being fairly firm on dry days except where intersected by drainage rivulets, it could be seen that the Courida trees, with the exception of a few on which one or two green branches remained, were all dried up and dead, and that the usual pneumatophores which cover thickly the mud below healthy living trees were absent. But on nearing the back of the beach, the bare mud, which was there soft, was occupied by large patches of Spartina, and a strip of Courida trees about 50 yards wide, immediately behind the beach, remained quite green and healthy, with abundant pneumatophores. The seaward edge of the Courida ended abruptly on firm sand, which was bare except for isolated plants of Spartina and a few creeping plants of Crab Grass (*Sporobolus virginicus.*)

This death of all the Courida trees, which were twenty feet high and more and some 9 or 10 years old, taking place as it did within a year or two, over a large area, is rather difficult of explanation. The following suggestion is however put forward for what it may be worth.

Courida trees can be found in habitats varying from the muddy foreshore immediately behind the neap tide mark to those cases where old trees are found in lowlying land behind the Sea Wall, where the sea never penetrates, but where the water is sometimes brackish (*e.g.*: on Thomas Lands, near the Sea Wall). In such latter situations however, only mature plants can exist, and seedlings cannot become established. But in places where Courida grows well, there is movement of the water about the roots, more especially on the tidal foreshore, where the soil water moves up and down with every tide. Since the formation of the new beach, however, this subsoil movement of the water in the area behind it, which is only covered by spring tides, is very greatly reduced, leaving the Courida for long periods in wet mud in which the water has become practically stagnant. This it is suggested causes asphyxiation and death of the plants. A contributory factor may possibly be found in the raising of the mud level by the inwash of 'sling' mud brought by the spring tides, but this has not raised the general level of the mud very rapidly, and in healthy trees the pneumatophores would doubtless develop to keep pace with it.

But not only has the Courida been killed on this foreshore mud flat; the Spartina too, is dying. Whereas two years ago it extended from opposite Bel Air Hotel westward to Kitty groyne, it is now dying back from the east as far as the Police riding ground, leaving nothing but bare mud. The dry periods between spring tides probably account for this, the caked surface that forms during these periods being quite inimical to the Spartina.

On these bare areas of mud, covered only by spring tides, where the Spartina and Courida have died, and also on the area originally cleared of

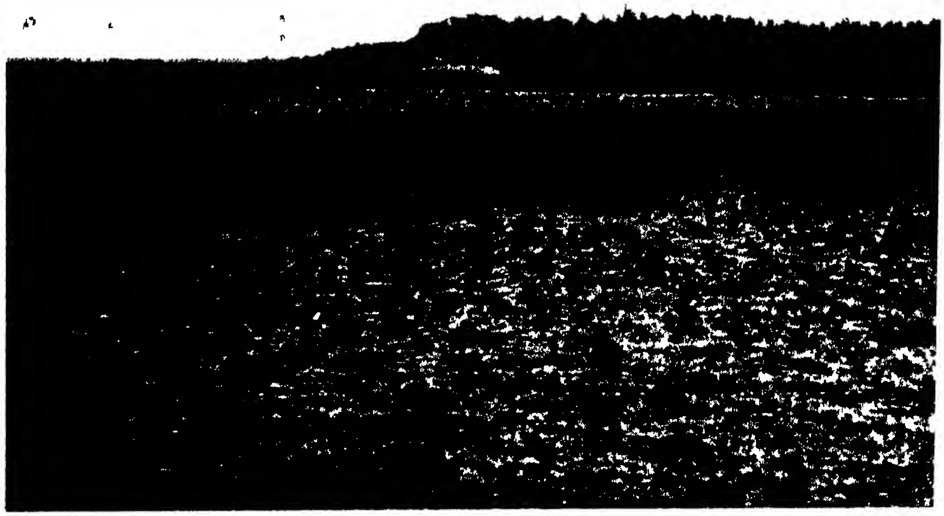

Fig. 1.—The Seaward Edge of the Courida at Liliendaal Note the narrow strip of healthy plan backed by the dead trees and the bare mud in the foreground—cf. Plate II, Fig 2 *loc cit*

Fig. 2.—Rice Grass West of Kitty Jetty, May 1939. cf Plate II, Fig 1, *loc cit*

Courida by felling, little or nothing seems able to become established. It was thought that possibly the Black Mangrove (*Rhizophora* spp.) might be grown, and with this end in view some small plots were fenced with barbed wire, sites being selected both close to the sea wall and further out, and *Rhizophora* seedlings brought from the Demerara River were planted therein. They did not however prove satisfactory and after a month or so all had died out, though possibly if greater care and attention could have been given them some of the plants might have become established.

It would seem that no vegetation will be able to establish itself naturally on this area until it is no longer covered even by spring tides, and the salt can leach out of it. At present the dry periods between spring tides prevent the establishment of halophytes, and the salt content of the mud, consequent upon its periodic covering by sea water, is too great for other forms of plant life.—E B.M.

Plant Inspection Service. During the period March 1 to May 31, 1939, 73 import certificates were issued for plant material entering the Colony and 34 export certificates for plant material leaving the Colony.

PLANT AND SEED EXCHANGE.

For the period ending May 1939.

INTRODUCTIONS.

Name	Quantity.	Whence Supplied
Economic.		
Sugar Cane—7 varieties	Cuttings of each	Plant Quarantine Station, Dept. of Agriculture, Trinidad.
Rice—6 varieties	6 lb.	Rice Research Officer, Burma.
„ 8 varieties	1 oz. each	Botanical Assistant, Assam, India.
16 samples	2 oz. each	Botanical Assistant, Karimganj Farm, Assam, India.
Musa textilis	suckers	Agricultural Superintendent, St. Vincent.
Tobacco Seed—Hickory Pryor	2 oz.	T. W. Wood & Sons, Virginia.
Vegetable Seeds	2 lb.	Messrs. Sutton & Sons, Reading, England.
Sunn Hemp (*Crotalaria juncea*)	4 lb.	Imperial College of Tropical Agriculture, Trinidad.
Soya Bean—5 varieties Jogun, Hokkaido, Willomi, Imperial and Emperor	2 oz. each	Univ. of Illinois, U.S.A.
Ornamental.		
Calophyllum Inophyllum	2 oz.	F. G. Walsingham, Harvard Univ., Atkins Institution of the Arnold Arboretum, Cuba.
Gmelina arborea	3 oz.	Director of Agriculture, Reduit, Mauritius.
Cordeia madagascariensis	do.	do.
Araucaria Cunninghamii	do.	do.
Pseudophoenix sargentii	4 oz.	Arthur Langlois, The Retreat, Nassau, Bahamas.
Flower Seeds	2 lb.	Messrs. Sutton & Sons, Reading, England.
Various Ornamental Seeds	7 packets	The Curator, Univ. of Stellenbosch, South Africa

PLANT AND SEED EXCHANGE—(*Contd.*)

DESPATCHES.

NAME	QUANTITY	DESTINATION
Economic.		
Dwarf Bonavist	14 oz.	Dr. D. S. Fernandes, Dept of Agrl. Economics, Surinam.
Padi—3 varieties	16 oz	The Rice Specialist in charge, Rice Research Station, Bihar, India.
" 5 "	1 packet each	Rice Research Officer, Rangoon, Burma, India.
" 4 "	do.	Botanical Assistant, Govt. Rice Exptl. Farm, Assam, India.
" 4 "	do.	Botanical Assistant, Karimganj, Assam, India.
" 10 "	2 oz. each	Director of Plant Breeding, Dept. of Agriculture, Sydney, New South Wales Australia.
Beans—3 varieties	3 packets	do.
Padi No. 79	6 oz	Director, Dept. of Science & Agriculture, Jamaica.
Peas & Beans—9 varieties	8 packets	do.
Pineapple—2 varieties	15 suckers	Director of Agriculture, Trinidad.
Panama Papaw	1 packet seeds	Director of Agriculture, Freetown, Sierra Leone.
Ginger—3 varieties	Roots of each	do.
Passiflora hispida	1 packet	Director, Royal Botanic Gardens, Kew, Surrey, England.
Solanum sessiliflorum (Cubieu)	1 packet	do
" " "	1 packet	Imperial College of Tropical Agriculture, Trinidad.
Ornamental.		
Assorted Ornamental Seeds	6 packets	The Superintendent, Govt. Gardens in Mysore, India.
Victoria regia	1 packet seeds	U.S. Dept. of Agriculture, Mayaguez, Puerto Rico.
Assorted Ornamental Seeds	7 packets	New York Botanic Gardens U.S.A. (through Mr. Stanley G. Ranger).
Orchids—2 varieties	'cuttings' of each	do.
Assorted Ornamental Seeds	19 packets	Private Collectors.
Orchids—8 varieties	'cuttings' of each	do.

METEOROLOGICAL DATA—JANUARY TO MARCH, 1939.

Recording Stations & Months.	Rainfall. Total Inches.	NUMBER OF DAYS OF RAIN: Under .10 Inch	.10 to .50 Inch	.50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days	Evaporation. Inches	Air Temperature and Humidity. Maximum.	Minimum.	Mean.	Humidity Mean.
Botanic Gardens.												
January ...	12.61	7	9	4	4	1	25	3.57	83.4	74.9	79.1	82.4
February ...	3.93	6	8	3	...	...	17	4.58	83.3	74.5	78.9	78.7
March ...	4.66	5	11	1	1	...	18	5.32	83.5	75.2	79.3	77.4
Totals	21.20	18	28	8	5	1	60	13.47	...	...	...	...
Means	...	...	...	...	...	...	...	...	83.4	74.9	79.1	79.5
Berbice Gardens.												
January ...	5.37	8	7	2	1	...	18	...	85.1	74.3	79.7	78.9
February ...	6.26	9	6	5	1	...	21	...	84.1	74.1	79.1	84.3
March ...	12.98	4	10	2	3	2	21	...	84.3	73.8	79.0	82.7
Totals	24.61	21	23	9	5	2	60	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	84.5	74.1	79.3	81.9
Onderneeming.												
January ...	10.53	1	9	3	3	1	17	...	86.1	73.9	80.0	92.7
February ...	7.18	1	6	3	2	...	12	...	85.4	73.1	79.2	93.1
March ...	8.43	...	6	...	2	1	9	...	85.2	73.3	79.2	93.3
Totals	26.14	2	21	6	7	2	38	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	85.6	73.4	79.5	93.0
Hosororo, North West District												
January ...	13.29	7	13	2	1	2	25	...	83.2	68.4	75.8	86.1
February ...	3.53	9	11	...	...	...	20	...	84.2	67.2	75.7	81.6
March ...	1.78	10	5	...	...	...	15	...	85.4	68.7	77.0	79.3
Totals	18.60	26	29	2	1	2	60	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	84.3	68.1	76.2	82.3

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Sugar

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The

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EDITORIAL.

FOOD SUPPLIES.

There are many indications that the local agriculturist will advisedly pay more attention to the production of food crops The Earl de la Warr Nutrition Committee draws attention to the prevalence in the Colonial Empire of deficiency diseases, lowered resistance to other diseases and general impoverishment of well-being and efficiency. One of the ways of combating this condition is to increase the supplies of fruit and vegetables in the home plot. In the Editorial of the *Farm Journal* of January 1938 it was stated : " The family cow for the farm, for instance, should be more in evidence so that even those who cannot afford to purchase milk in sufficient quantities may not be deprived of its benefits. Fruit trees (oranges, papaws, etc.) may be put in, in vacant spots, even if the conditions are not considered ideal and even if the types or varieties which succeed are not the most suitable from the cash sale point of view. The kitchen garden with its supply of vegetables—even if the grower is not near enough to a populous centre for truck gardening to be profitable—should be established to supply the home's needs. Thus can our farmers take an important step in safeguarding and increasing their supplies of protective foods. To induce thinking along these lines the British Guiana Department of Agriculture is encouraging its district officers to mention this feature prominently when opportunities for group talks occur."

An even more insistent demand on farmers to think along these lines is now made by the declaration of war. The recent wars that have been fought have not been short; interference with shipping and so with supplies has been a chief weapon; it is probable, therefore, that imports, even if obtainable, will be costly. Clearly, an increase in the production of articles planned to render the Colony self-sufficient is likely to prove not only desirable and helpful but necessary.

During the first half of this year reports indicated that an increase of existing sugar export quotas was likely to take place because of short crops in India and Europe and the accumulation of war supplies by different Governments. With the outbreak of war further revision is not improbable; it is possible that with beet sugar production disorganized in Europe, colonial output, instead of being restricted, may be encouraged. The sugar estates in cane farming areas have already notified farmers that increased plantings should be proceeded with. The Department has endeavoured consistently to foster cane farming which appears in many ways to be an industry likely to afford a type of enterprise well suited to our agricultural population. In conjunction with other of the Department's efforts an economic survey was carried out among the cane farmers at East Demerara. As a result attention was drawn to certain cane-farming practices which can advantageously be modified. For example, although it is known that since the survey was taken many farmers are trying the higher yielding varieties, up to 3 years ago practically all (91%) of the farmers stated that D 625 was the only variety they had in cultivation. It was found that although extremely few farmers did not use fertiliser, the applications in a large percentage of cases were only half of what they should be. It was interesting to note a tendency for the younger farmers to use more fertiliser than the older farmers and for East Indians to use more than West Indians. These and other findings make it possible for the Department's extension officers to supply cane farmers with definite and specific advice.

Rice production should also be expanded, for this crop provides the supply of a staple article of diet which is certain to find an increasing demand both locally and in the neighbouring West Indian Colonies. In this connection the growth of a spring crop where conditions permit suggests itself as a practice which is to be encouraged for more general adoption. It has for a long time been claimed by growers that low prices have been the chief factor discouraging increased plantings; the likelihood of sharp price advances is in itself likely to give production an initial and probably important fillip.

These are a few indications of the changing situation which farmers are being called on to meet. Peas and beans can and should be considerably extended. Food committees have been appointed—one to control prices and one to encourage food crop production. Agriculturists and farmers generally will be advised to prepare for the end of the year rains so that no delay in getting cultivations established will be experienced. The question of seed supplies and planting material generally is receiving the attention of the Department.

ORIGINAL ARTICLES.

ACIDITY AND "ACTIVE" ALUMINA IN BRITISH GUIANA SUGAR-CANE SOILS.

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I. INTRODUCTION.

In 1932 Follett Smith (8) pointed out that, during the past thirty years, a marked change has taken place in the reaction of the topsoils of the sugar cane lands of this Colony. In 1908 the water extracts of 87 samples examined by Sir John Harrison were all alkaline to litmus, while in 1931-32 only 12 topsoils out of 2,893 (0.4 per cent.) had a reaction value above the neutral point (pH 7). Quoting Follett Smith "It is likely that this marked increase in soil acidity, which has taken place in a comparatively short space of time, is progressive, and that, if the present system of agriculture is continued, the cane soils of the Colony will in the future reach a degree of acidity incompatible with the growth of heavy crops of cane".

Later, Follett Smith (9) showed that applications of sulphate of ammonia totalling 12-18 cwt. per acre over a three-crop cycle caused a statistically significant depression of the topsoil pH. Manurial trials with ground limestone and slaked lime have shown that, generally speaking, flood-fallowed clay soils do not respond to liming materials, whereas unflooded clay soils do. On pegasse soils there has been some response to small dressings (1 ton per acre) but no economic return from dressings which approached the lime requirement of the soils.

It has been recommended by this Department that, as a preventive measure, one ton of limestone per acre should be applied at planting, this being more than sufficient to counteract the acidity developed during the previous crop cycle. This liming programme was designed as an insurance against the possible effects of extreme acidity, but it is necessary to find the factors involved in this change from alkaline to acid in order to judge whether or not the growth of cane will ultimately be affected.

II. SOIL ACIDITY.

For the present purpose it is preferable to consider particularly the acidity of the sugar cane soils of this Colony, rather than to generalise on a chemical subject which is too complex for simple explanation. Harrison (12) found

that the alkalinity of the clay soils was due to the presence of sodium carbonate and the double carbonate of sodium and magnesium. During the dry season, evaporation of the soil waters resulted in an increased concentration of these salts, sometimes to an extent which injured the cane. Thus, soil alkalinity may be undesirable, and Harrison ascribes the improvement of these soils on cultivation to be due largely to the washing out of sodium salts, and to the correction of the alkalinity of the subsoil waters when sulphate of ammonia is applied as a fertiliser. This shows that the acidifying effect of sulphate of ammonia was not harmful to these saline soils, as it favoured the washing out of the undesirable sodium salts by converting them from carbonate to the more soluble sulphate.

Evidence of the effect of flood-fallowing and irrigation in washing out salts from the soil was given by Follett Smith. He analysed the water on five flood-fallowed fields (7), and from his figures it appears that flood-fallowing removes from one acre 2 to 4 tons sodium chloride, 3 to 4 tons magnesium sulphate, and ½ to 1½ tons carbonate of lime. In another investigation (8) he estimated the total salt content of the top and subsoils of three fields which were suspected of being affected by excessive salinity. Two sets of samples were taken, with an interval of five months, during which time the area was flushed on five occasions, and in addition both banks were forked after planting, a bed-drill two feet wide by one foot deep was made in the original first bank, and the small drains of the fields were dug an extra shovel deep. Table I gives the salt content of the three sets of soil samples before and after the treatment.

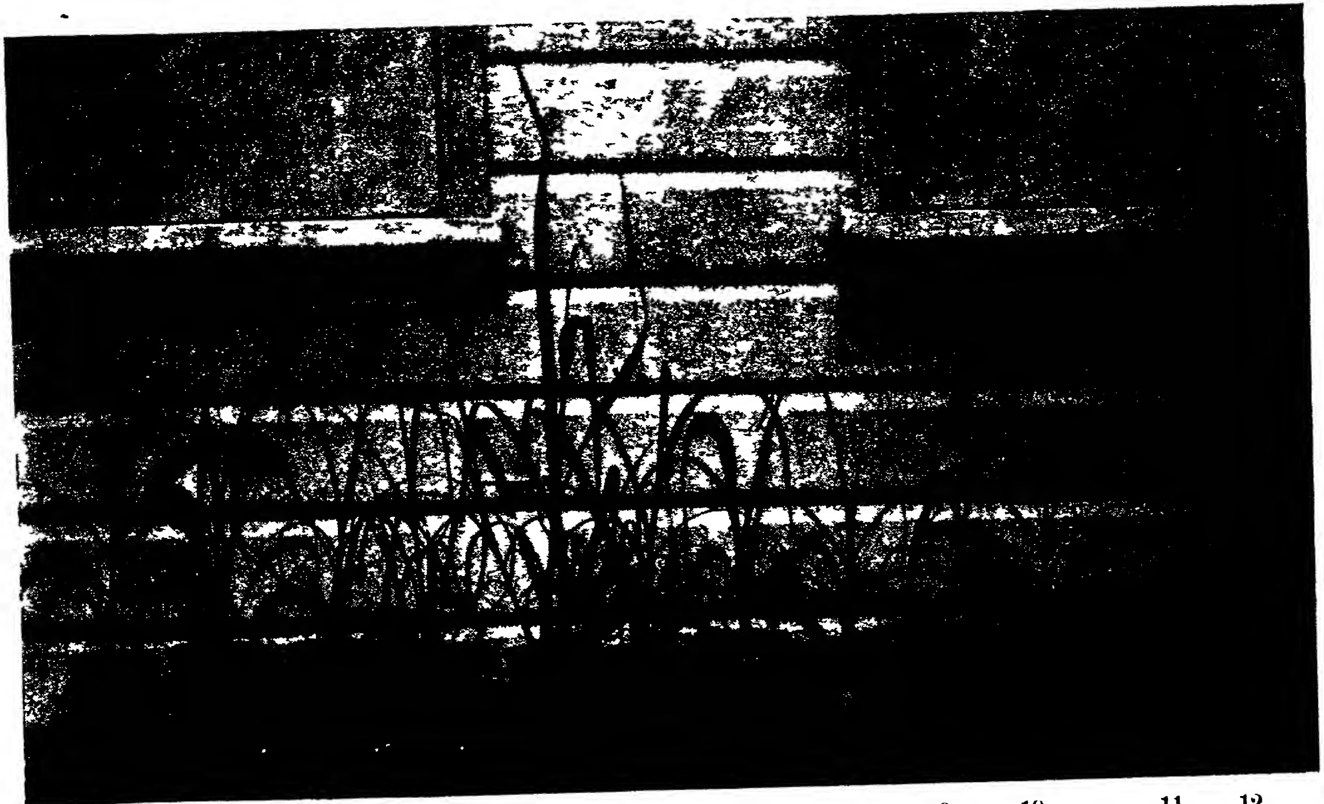
TABLE I.

Per Cent. Soluble Salts.

Date sampled:		1.4.32.	27.8.32	Tons removed per acre-foot.
Field 1.	Topsoil	0.159	0.088	1 3
	Subsoil	0 165	0 121	0.8
Field 3.	Topsoil	0.256	0 090	3.0
	Subsoil	0.367	0 289	1.4
Field 6	Topsoil	0.314	0.099	3.8
	Subsoil	0.407	0.259	2.6

Thus the original change from alkaline to slightly acid, which took place in the coastland clay soils, was probably due to the washing out of alkaline salts and *not* to the liberation of acid from sulphate of ammonia. Padi soils should give some idea of the acidifying effect of removing salts, as they have been cultivated for many years without manuring, and under conditions which favour the washing out of soluble salts. It is reasonable to assume that the padi soils of this Colony were originally alkaline, like the sugar cane soils,

PLATE I.



	1	2	3	4	5	6	7	8	9	10	11	12
pH (Approx. Average)	7	7	6	6	4	4	3	3	2 5	2 5	2.5	2 5

Cane Seedlings Growing in Acid Medium.

and Table II gives the reaction distribution of sugar cane top and subsoils from Follett Smith's data (8), compared with similar padi soil data from unpublished records in the Chemical Division.

TABLE II.

Reaction Distribution of Sugar and Padi Soils.

	TOPSOILS (0–12″)		SUBSOILS (12–24″)	
Normal Reaction	Sugar	Padi	Sugar	Padi
below pH 4.00—very highly acid	10 (0.5%)	—	30 (1%)	—
pH 4.00–4.99—highly acid	1,487 (51%)	13 (17%)	1,387 (48%)	5 (11%)
pH 5.00–5.99—markedly acid	1,260 (44%)	53 (72%)	860 (30%)	17 (39%)
pH 6.00–6.99—slightly acid	124 (4%)	8 (11%)	541 (19%)	14 (32%)
above pH 7.00—alkaline	12 (0.5%)	—	75 (2%)	8 (18%)
Total No. of Samples	2,893	74	2,893	44

The figures in Table II show that the padi topsoils have also changed from alkaline to acid, and the fact that their subsoils are less acid than the topsoils is further evidence of this change. On the whole the padi soils are not so acid as the sugar soils, but these sugar soil samples include pegasse and pegassy clay, which form about 25% of the sugar soils of this Colony. These peaty soils are by nature more acid than the clay soils, and padi is grown only on clay. However, the main point is clear, that the padi soils of the Colony are also markedly acid, although they have not been treated with sulphate of ammonia.

The fact that the majority of padi topsoils lie between pH 5 and 6 may be taken as an indication that the sugar soils might have reached this level of acidity even although no sulphate of ammonia had been used. Thus the continued use of sulphate of ammonia may not have been responsible for the initial change from alkaline to acid, but it is probably the main factor in the increasing acidity which is seen today on the more acid soils.

The acidifying effect of sulphate of ammonia on a heavy clay grassland soil was clearly demonstrated at Rothamsted Experiment Station (5) where plots which had received sulphate of ammonia continuously since 1863 showed pH values ranging from 3.8 to 4.8, the figure for unmanured plots averaging 5.8. It was found that with increasing amounts of ammonium salts the crop yield increased, but the herbage changed from a very mixed one with many leguminous plants into a rank growth of a few species of grasses with few or no leguminous plants or weeds. At the Woburn Experimental Farm a similar experiment was carried out on a sandy soil, and after continuous applications of sulphate of ammonia barley failed completely when the pH value dropped to 4.5.

In this investigation there is a striking difference in the degree of acidity at which grass and barley could grow. Several species of grass were still growing luxuriantly at pH 3.8, whereas barley failed completely at pH 4.5. A small pot experiment with cane seedlings was set up to find whether sugar cane would grow under highly acidic conditions. White sand was used, irrigated by a simple nutrient solution containing mono-calcium phosphate, sodium nitrate, potassium chloride, magnesium sulphate and the minor elements iron, manganese, boron, zinc and copper (6). The solution was adjusted every day with dilute nitric acid at pH's ranging from 7 to 2, but it was difficult to maintain the solution at definite pH's, owing to lack of buffering. Nevertheless the acidity gradient was sufficiently wide to prove the point that cane seedlings *can* grow, for a time at least, in solutions of higher acidity than any natural soil solutions. Plate I shows the seedlings, 2—3 months old, and it will be seen that the seedlings at the highest acidity (pH 2.5) did not grow so well as those in less acid solutions, but those about pH 4, which would be very highly acidic for a soil solution, looked quite as healthy as those near neutrality (pH 7). However, this does not mean that cane would grow in a *soil* of pH 2—3, for other factors come into play in the highly complex soil system.

The relationship between soil acidity and fertility has been summed up by Robinson (17) as follows : "Soil acidity cannot enter into the problem of soil fertility as an independent factor, for it is correlated with a deficiency of available calcium, and also, in some cases, with the presence of actively toxic aluminium compounds. Indeed, M. Trénel and F. Alten have demonstrated in culture solutions that aluminium, active below pH 5.0, acts as a specific root poison. Further, in some cases, soil acidity may be correlated with undesirable physical conditions. It is thus not easy to assert generally that soil acidity, *per se*, is a limiting factor. The limitation may actually be due to lack of available calcium, the presence of active aluminium, or the prevalence of an undesirable physical condition."

Taking the first and last of these factors together, the fact that flood-fallowed clay soils do not respond to dressings of limestone or slaked lime is an indication that an absolute lack of available calcium is not the limiting factor. On the highly acidic pegasse soils, however, dressings of 1 ton limestone have given definite increases in yield, but larger dressings did not give economic responses. This means that the addition of calcium, as well as the correction of acidity, is important. On unflooded clay soils there was a response to liming, and this introduces two factors—physical condition of the soil and the supply of available calcium. Flood-fallowing has been shown by Follett Smith (10) to improve the texture of the soil, and liming is also a well-known method of improving soil tilth. It is obvious that on this consideration liming could never replace flood-fallowing, and the marked benefit conferred by the latter tends to rule out texture as a key point in this soil acidity problem. On the other hand, analysis of soils before and after flooding showed an increase in the exchangeable lime, and this may mean that flood-fallowing helps to correct any tendency to absolute deficiency of calcium by releasing some of

the insoluble calcium of the clay minerals. Further evidence of this is given earlier in this section, as flooding water was found to contain ½ to 1½ tons of carbonate of lime per acre.

Thus the supply of available calcium may be maintained by flood-fallowing, and economic responses on flooded clay soils will be obtained only when the reserve of calcium has been depleted. As to how long this reserve supply of calcium will last, we have no certain means of judging, because the amounts removed during flood-fallowing and irrigation are difficult to measure accurately. In a recent article. Sir John Russell (18) tells of wheat plots at Rothamsted which have received no manure for a hundred years. The yield fell from 20 bushels to 10 bushels per acre, but with better cultivation in recent years (still without added manure) the yield has risen to 24.6 bushels. One plot which was dry-fallowed in 1937 gave 39 bushels in 1938. Quoting from this paper : "Clearly it is a very long business waiting for crop yields to come down simply by the process of exhausting the plant food from the soil."

In British Guiana this process of soil exhaustion is greatly hastened by flood-fallowing and irrigation. A soil sample from the Botanic Gardens, analysed by Sir John Harrison, gave a total content of calcium oxide of 0.51% which, taking 1 acre-foot of clay to weigh 2,000 tons, means that there is a reserve of topsoil oxide of lime of 10 tons per acre, or, converting this to carbonate, 18 tons carbonate of lime. Of this, ½ to 1½ tons is removed in flooding water every fourth year, apart from what is removed in the cane crops and in irrigation water. Of course, flood-fallowing also taps the mineral reserves of the subsoil, but even then an appreciable proportion of the lime reserve is removed by the practice of flood-fallowing. Even so, the process of exhaustion will take many years, and the regular application of ½ to 1 ton of limestone at planting is sufficient to prolong it indefinitely.

Thus, as far as we can judge at present, calcium deficiency and undesirable physical texture, due to the continued use of sulphate of ammonia, are not likely to be serious factors on clay soils for many years. The lack of response to liming on flood-fallowed soils, compared with the marked response to liming on clay soils in other countries may be due to the fact that the main effect of liming is the improvement of soil texture, and that is achieved in this Colony by flood-fallowing.

The third factor involved in soil acidity, namely aluminium toxicity, is examined in some detail in the next two sections.

III. "ACTIVE" ALUMINA AND SOIL ACIDITY.

Most aluminium compounds are insoluble and take no part in plant nutrition, but it has been found by water and sand cultures that soluble aluminium compounds, such as the sulphate, can act as specific root poisons. In normal soils the amount of aluminium in solution is negligible in this respect, but under some conditions aluminium toxicity becomes an important, even a limiting, factor.

This subject has been studied in considerable detail, and the rôle of aluminium in soil infertility and toxicity is discussed in a review paper by Hardy (11). Blair and Prince (2) studied a loam which had become so acid (pH 4.7), owing to continued fertilisation with sulphate of ammonia, that no ordinary farm crops would grow on it. They found that acidity *per se* was not responsible for the infertility of the soil, and concluded that soluble aluminium compounds constitute one of the causes of toxicity in soils by hindering root development. This toxicity could be counteracted by heavy applications of soluble phosphates, or of basic materials such as lime or basic slag. Later, Blair and Prince (3) found that, as a soil becomes increasingly acid there is a rise in the amount of "active" alumina (*i.e.*, alumina soluble in 0.5N acetic acid), which may reach a toxic level. They also found that a highly acidic soil (pH 4.07) could have its content of active alumina reduced by treatment with limestone, acid phosphate, or basic slag, the latter being the most effective. Ammonium salts, *e.g.*, sulphate of ammonia, tended to increase the amount of active alumina in the soil, *apart from any acidifying effect of the fertiliser.*

In 1926 Line (13) criticised very strongly most of the previous papers on toxic alumina in soils, and he submitted evidence that the "toxic aluminium" theory of acid soils is no longer tenable. But the contents of "active" alumina which he gives for his experimental soils are low (up to 66 parts per million) compared with those of soils used by other workers, and with those of British Guiana soils given elsewhere in this paper (up to 1,000 p.p.m.). Further, he makes no distinction between the *presence* of soluble alumina and the *presence of toxic amounts* of soluble alumina.

In the same year, Blair (1) reported that a soil sample was received at the New Jersey Experiment Station accompanied by the statement that "nothing would grow on it." Analysis showed that it was very acid and that it contained a high percentage of aluminium salts soluble in dilute acid. Greenhouse experiments with barley showed no growth, even when nitrate of soda and muriate of potash were added. When, however, in addition to these there was added a substance with the power of rendering the aluminium compounds insoluble, such as lime, basic slag, or even acid phosphate in excessive amount, the barley grew luxuriantly. The interesting point is that where the acid phosphate was used in heavy applications without lime, the soil still remained acid but the barley grew as well as when lime was used. Blair considers that it is more important to put out of action the soluble aluminium compounds than to correct the acidity.

The relationship of active alumina and soil acidity has formed the basis of many studies related to field problems. Magistad (16) found that it was only outside the pH range 4.7 to 8.5 that appreciable quantities of soluble alumina occurred in the soils which he tested. Thus pH 4.7 appeared to be the "danger-point," but he also found that aluminium phosphate is precipitated at pH 3.9, so that the presence of large amounts of phosphate would

lower the danger-point from pH 4.7 to 3.9. This explains Blair's findings that acid phosphate could correct the effect of alumina without raising the pH of the soil. This was confirmed by McLean and Joffe (15), who found that sulphate, as well as phosphate, prevented aluminium going into solution, since it suppresses the change from colloidal to molecular dispersion.

It may be, therefore, that the use of sulphate of ammonia as a source of nitrogen has hindered the accumulation of toxic amounts of soluble alumina, although its acidifying action has brought the soil nearer to the danger point. This danger-point is complicated by the presence of phosphate or sulphate; for instance, one field with pH 4.2 might have toxic amounts of alumina present, while another, with the same pH but more phosphate or sulphate, would have less alumina in the soluble form.

We have, in "active" alumina, a toxic principle which has proved to be of importance in other countries, and which may come into play now that the sugar cane soils are reaching a high degree of acidity. Accordingly, a laboratory investigation was carried out to find the extent to which it occurs in clay and pegasse soils, and this is reported in the next section.

IV. "Active" Alumina in Clay and Pegasse Soils.

Since aluminium toxicity seems to be a probable result of excessive acidity, a series of determinations was carried out in order to find the content of "active" alumina in clay and pegasse soils. The analytical method employed was that of Burgess (4), in which the active alumina is extracted with 0.5N acetic acid.

Table III gives the data for typical clay and pegasse sugar cane soil profiles. Further analytical data for these profile samples appear in a report by Follett Smith (8). The figures for active alumina are parts per million of air-dry soil.

The figures in Table III illustrate what may be a key point in the problem of soil acidity on the sugar lands of this Colony. It is striking that the pegasse surface soil contains over 50 times as much active alumina as the clay surface soil. It happens that this clay soil contains much less active alumina than others reported below, but the general principle remains, that the pegasse soils contain higher amounts than do the clays. The practical significance of this is that the clay soils, compared with pegasse, are less likely to accumulate toxic amounts of soluble alumina, and therefore we should expect to find the detrimental effects of acidity on pegasse much earlier than on clay—if, indeed, the latter ever reaches the limit of tolerance for cane.

The next step was to find the effect of a change of soil reaction on the content of active alumina. For this, composite samples of clay and pegasse were treated with graded amounts of lime water and 0.1N sulphuric acid, allowed to dry in the air, rewetted and dried, and then subjected to analysis.

TABLE III.

Active Alumina in Clay and Pegasse Profiles.

Sample No.	Depth.	pH	"Active" Al_2O_3 p.p.m.
Frontland Clay.— (Field 4 W. Sophia)			
D. 636	0— 6 ins.	5.09	21
D. 637	6—12 ,,	4.96	32
D. 638	12—18 ,,	4.98	21
D. 639	18—24 ,,	6.34	16
D. 640	24—30 ,,	6.89	16
D. 642	36—42 ,,	7.37	51
Pegasse Soil— (Field 30 W. Uitvlugt)			
D. 685	0— 6 ins.	5.61	1212
D. 686	6—12	5.02	805
D. 687	12—18	5.20	549
D. 688	18—24	4.93	381
D. 689	24—30	4.54	120
D. 690	30—36	4.85	101
D. 691	36—42	4.93	73
D. 692	42—48	4.95	94
D. 693	48—54	5.02	51
D. 694	54—60	4.62	51
D. 695	60—66	4.60	73
D. 696	66—72	4.21	616

Table IV gives the relevant data, and it will be seen that the untreated clay soil contains five times as much active alumina as the surface soil of the clay profile in Table III. Nevertheless this amount is still much less than that in the pegasse soil.

It is clear from Table IV that with increasing acidity there is an increase in the content of aluminium extractable by 0.5N acetic acid. It is interesting that in both soils there is a comparatively large increase at pH 4.7, but the possibility of aluminium toxicity in the clay soil at that pH is much less than in the pegasse, since the latter contains over four times as much active alumina as the clay. While pH 4.7 seems to be, in theory, the danger-point for pegasse, it is not possible to fix such a point without some knowledge of the tolerance of different cane varieties for soluble aluminium salts. In this connection McGeorge (14) in Hawaii found a difference between varieties in tolerance for soluble alumina, and work along this line ought to be a useful adjunct to

TABLE IV.

Effect of Increasing Acidity on Content of Active Alumina.

Treatment.	pH	Active Al_2O_3 (p.p.m.)
Composite clay soil (Sophia).		
100 gms. soil + 60 ml. $(Ca\ OH)_2$	7.29	163
untreated soil	6.77	121
100 gms. soil + 5 ml. O. 1N H_2SO_4	6.53	121
„ „ + 12 „ „ „	6.21	121
„ „ + 18 „ „ „	5.90	142
„ „ + 25 „ „ „	5.64	163
„ „ + 35 „ „ „	5.15	184
„ „ + 55 „ „ „	4.70	234
„ „ + 80 „ „ „	4.31	278
„ „ +105 „ „ „	4.04	301
Pegasse topsoil (0—1 ft.) D. 888, Uitvlugt.		
115 gms. soil +345 ml. $Ca\,(OH)_2$	5.99	648
„ „ +230 „ „	5.64	690
„ „ +115 „ „	5.08	794
untreated soil	4.70	961
115 gms. soil + 10 „ O. 1N H_2SO_4	4.36	961
„ „ + 20 „ „ „	4.25	1030
„ „ + 30 „ „ „	4.08	1104

breeding work in this Colony. The slight increase in active alumina in the limed clay soil (pH 7.29) recalls Magistad's observation (16) that soluble alumina occurs in appreciable quantities in highly alkaline soils.

V. SUMMARY AND CONCLUSIONS.

1. The sugar cane soils of British Guiana have changed from alkaline to markedly acid in the past thirty years, and this acidity is still increasing owing to the use of sulphate of ammonia.

2. The original change from alkaline to slightly acid was probably caused by the washing out of alkaline salts of sodium and magnesium, and was not directly due to the acidifying effect of sulphate of ammonia. Padi soils, which have received no sulphate of ammonia, are now generally acid.

3. Cane seedlings can grow for some months in a nutrient solution which is much more acid than any known soil solution.

4. From work in other countries it appears that the most likely effects of excessive soil acidity are an undesirable physical condition, calcium deficiency, or aluminium toxicity.

5. Flood-fallowing results in a marked improvement in tilth, and it is unlikely that liming will supersede this cultural practice as regards improvement of texture.

6. Absolute deficiency of calcium is not indicated at present on flood-fallowed clay soils, as they do not respond to light dressings of limestone. On the pegasse soils some response has been obtained to a small dressing (1 ton per acre) of limestone, and this may be an indication of a shortage of available calcium, since the quantity used was far from sufficient to correct the acidity.

7. There is an increase in available calcium after flood-fallowing which means that some of the insoluble calcium of the clay minerals has been rendered available.

8. Flooding removes appreciable quantities of salts in solution, and results in a loss from the soil of ½ to 1½ tons carbonate of lime per acre. This tends to deplete the reserves of calcium, and may eventually induce calcium deficiency. A response to small applications of limestone on flood-fallowed clay soils would be an indication that the supply of available calcium in the soil is not sufficient for the needs of the crop.

9. The content of "active" alumina in pegasse soils is high, and there is a possibility that it may reach a toxic level. In clays the content of active alumina is much lower.

10. With increasing soil acidity there is an increase in the amount of active alumina, but on the clay soils this is not likely to reach a toxic level.

11. Evidence of varietal differences in tolerance of soluble alumina has been found in Hawaii. This may account for the success of P.O.J. 2878 on pegasse lands, as compared with D. 625 and Diamond 10. Further investigations on this line might be of value in breeding work.

12. These observations suggest that, on the heavy clay soils, the ultimate result of increasing soil acidity would not be disastrous, as the application of moderate dressings of limestone or slag would quickly correct the toxicity. Nevertheless, the regular application of ½ to 1 ton of limestone at planting, as recommended by this Department, would prevent, or delay indefinitely, the adverse effects of excessive acidity. On pegasse and pegassy clays the high content of active alumina renders it important that a regular liming programme of at least 1 ton per acre at planting should be adopted.

REFERENCES.

1. BLAIR, A. W. (1926). New Jersey Agr. Expt. Sta. Bull. 430, 1926, p. 4.

2. ———and PRINCE, A. L. (1923). Studies on the toxic properties of soils. —Soil Science, Vol. 15, 1923, p. 109.

3. ———. (1927). The relation of soil reaction to active aluminium.—Soil Science, Vol. 24, 1927, p. 205.

4. BURGESS, P. S. (1923). A method for the determination of "active" alumina in acid soils.—Soil Science, Vol. 15, 1923, p. 131.

5. CROWTHER, E. M. (1925). Studies on Soil reaction IV. The soil reaction of continuously manured plots at Rothamsted and Woburn.—J. Agr. Science, Vol. 15, 1925, p. 222.

6. ELLIS, C. AND SWANEY, M.W. (1938). "Soilless Growth of Plants," p. 146.—Reinhold Publishing Corp., New York.

7. FOLLETT-SMITH, R. R. (1931). B.G. Dept. of Agr. Ann. Rept. Chemical Division, 1931.

8. ———. (1932). B.G. Dept. Agr. Ann. Rept. Chemical Division, 1932.

9. ———. (1936). B.G. Dept. Agr. Ann. Rept. Chemical Division, 1936.

10. ———and ROBINSON, L. A. (1936). Flood-fallowing.—Agr. J., British Guiana. Vol. 7, 1936, p. 227.

11. HARDY, F. (1926). The rôle of aluminium in soil infertility and toxicity. —J. Agr. Science, Vol. 16, 1926, p. 616.

12. HARRISON, SIR JOHN (1908). Varieties of sugar cane and manurial experiments in British Guiana. West Indian Bull. Vol. 9, 1908, p. 1.

13. LINE, J. (1926). Aluminium and acid soils.—J. Agr. Science, Vol. 16, 1926, p. 335.

14. MCGEORGE, W. T. (1925). The Influence of aluminium, manganese and iron salts upon the growth of sugar cane and their relation to the infertility of acid island soils.—Expt. Sta. Hawaiian Sugar Planters' Asso., Bull. 49, 1925.

15. MCLEAN AND JOFFE (1927). Ann. Rept. Soils Division New Jersey Agric. Expt. Sta. 1927, p. 333.

16. MAGISTAD, O. C. (1925). The aluminium content of the soil solution and its relation to soil reaction and plant growth.—Soil Science, Vol. 20, 1925, p. 181.

17. ROBINSON, G. W. (1936). "Soils, their Origin, Constitution and Classification."—2nd edition, p. 424. Murby and Co., London.

18. RUSSELL, SIR E. JOHN. (1939). The trend of progress in crop production.—Chem. & Ind. Vol. 58, 1939, p. 664.

EXPERIMENTAL CULTIVATIONS IN THE NORTH WEST DISTRICT—1928-1938.

BY

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INTRODUCTION.

In the year 1907, when the cultivation of rubber-producing trees held promise of playing an important part in local agricultural practice, the Department of Science and Agriculture decided to start an experimental station in the North West District where rubber planting was already being carried out. The site selected was at Hosororo, on the Aruka River, and the station was placed in charge of an Agricultural Instructor. This Rubber Station was maintained until 1927, by which time such changes had occurred in the rubber market that the cultivation of the crop had been abandoned and the tapping of the trees on the station was no longer worth while. Besides rubber trees of varying kind, a small lime cultivation and a few odd trees of citrus and cacao, the station carried no other crop.

In 1927 Mr. H. C. Sampson, Economic Botanist of the Royal Botanic Gardens, Kew, visited the North West District during a tour of the Colony and envisaged the possible extension of citrus cultivation in the district. Shortly afterwards proposals were put forward for the introduction of settlers into the district. The Department of Agriculture therefore decided to extend the scope of the station to include the experimental cultivation of crops which might prove of value and more especially to start a citrus orchard, both to explore the possibilities of citrus culture on the few lateritic hills of the district, of which Hosororo was representative, and to establish a source of budwood to aid in the extension of citrus cultivation in other parts of the Colony. In August 1928, an Agricultural Superintendent was appointed to the district and placed in charge of the station and work was begun on the new programme. In February 1934 the Superintendent died and since that time the station has again been under the charge of the Agricultural Instructor of the district, supervised since 1935 by the Government Botanist.

In 1928 the Farmers' Association of the North West District was cultivating a small area of grey sand on the Wauna Creek, Koriabo River. After the survey of the district carried out in 1929 with a view to proposed settlement, it was found desirable to experiment with the possibilities of establishing permanent crops on soils of this type, which were found in much of the area surveyed and occurred also in other parts of the Colony. As Wauna offered the only readily accessible area on this soil type, it was taken over from the North West District Farmers' Association by the Department to be run as a sub-station to Hosororo, and cleared for planting, which was begun in 1930.

Work has now been carried out both at Hosororo and Wauna for ten years and these notes form a summary of what has been done and record the various crops that have been tried.

HOSORORO.

Description of the Soil.

Hosororo Hill is one of a series of lateritic hills, a few hundred feet in height, which rise up like islands in the pegasse swamp that covers the North West District near to the coast. It is on such high land that the Aboriginal Indians find suitable sites for growing their cassava, small areas being cleared, planted and then abandoned when one or two crops have been taken off. Hosororo itself, having springs and a fresh water creek ending in the fall from which the locality is named, must for centuries have been the site of such shifting cultivation, and in places, especially on the steeper slopes, the soil has suffered considerably from erosion, so that many areas are gravelly, with outcropping rock and stones only a few inches below the surface. One result of this has been that the selection of suitable areas for experimental cultivation has resulted in a rather scattered 'lay-out' of the station as a whole. The eastern end of the hill, where the station is situated, runs down into the pegasse flat that extends from the hill foot to the Aruka River. This pegasse area was the chief site of the former rubber cultivation. In 1929, after completing the 'colonisation' survey of the North West District, the Chemist-Ecologist examined the soils of the Hosororo Station and the following notes are taken from his Report *.

He refers to the area which includes Hosororo as follows (*loc. cit.* p. 3): " Rising from the swamp are dykes and bosses of intrusive plutonic rocks " some 200-300 ft. in height. They are covered with a blanket of red lateritic " clay mixed with nodules of concretionary ironstone." With regard to the station itself, he states (*loc. cit.* p. 27) : " The lateritic fine silt, which occurs " as a shallow covering to the Hosororo Hill and extends as a wide belt across " the centre of the station, is typical of similar areas occurring in the area " surveyed. It contains more organic matter, more available and total phos- " phate, and possesses a higher lime requirement, which differences are " presumably due to previous cultivation. It has already been pointed out that " a considerable amount of erosion has taken place on the hill slopes, and at " many points in the area so little fine earth remains that cultivation is " precluded." He also points out that the pegasse soil of the station, which had been in cultivation for many years, could not be taken as in any way " typical of the virgin pegasse of the vicinity." The average annual rainfall at Hosororo during the last ten years has been 106 inches.

The Crops Cultivated.

Citrus.

Varieties planted :

Oranges and Grapefruit. In 1928 an area of 2 acres was cleared on the hill to the south west of the station, immediately beyond the creek, and planted

* The Report of a Soil Survey of an area of the North West District of British Guiana. R. R. Follett-Smith, Dept. of Agric. Chem. Bull. No. 1, 1930.

in June with an assortment of budded citrus varieties obtained from Trinidad. Seven rows of twelve plants each were set out. In December of the same year six rows were added of Marsh grapefruit, budded at the Botanic Gardens with budwood obtained from Trinidad, and labelled 'Botanic Gardens Marsh' to distinguish it from the plants budded in Trinidad.

In 1929 another 53 Marsh from the Gardens were planted in May, to fill the original clearing, and during that year the whole citrus cultivation was increased to ten acres. To the west of the original planting, and separated from it by a windbreak of British Honduras Mahogany, planted at the same time, a further clearing was made. Here, an assortment of oranges, tangerines and Walters grapefruit, budded at the Botanic Gardens with Trinidad budwood, were planted out in June, totalling eight rows of eight plants each. Adjoining these also there were planted four similar rows of Duncan grapefruit, also budded at the Gardens. In addition, another field had been cleared to the south-west of the abovementioned area, and in this were planted six rows of Marsh grapefruit from the Gardens—ten plants in each. All the abovementioned plantings were on sour orange stock.

In 1930 two more rows of Duncan were added and from 1931 onwards the south-west field was gradually extended and planted with a variety of citrus including Marsh on rough lemon stock, lemons, tangelos, etc.

Limes. In addition an area of 5 acres had been cleared in 1929 on the south-east slope of Hosororo Hill and planted, half with limes budded on sour orange stock and half with seedling limes. These limes were all of a local variety established in the area, which tends to be large and rather rough-skinned, somewhat resembling a small lemon in appearance but with a definite lime flavour. It is too large and rough for the green lime trade, but is satisfactory as regards yield of juice and oil. It may possibly be akin to the Tahiti lime. The limes in the North West District however, are in general somewhat rougher and larger than those found on the coast and it was thought possible that these characteristics may in part be due to the locality and heavy rainfall. In addition, therefore, there were planted two rows (24 plants) of typical West Indian smooth-skinned limes from St. Lucia and 2 plants of a hybrid lime from Dominica, for comparison with the local lime, and to observe any possible effect of the locality upon them. The fruit borne by these has however, retained the smooth appearance characteristic of the West Indian lime and the local lime would therefore appear to be of a slightly different variety.

In 1936 a further addition was made to the lime collection at the station consisting of twelve plants of a British Guiana (Ceylon) lime, the origin of which was as follows. In 1932 a reference was noted in the Ceylon Agricultural Department's Journal to a "British Guiana" lime which was being extended in cultivation there. On enquiry it was found that the variety in question was very prolific and bore small, thin-skinned and very juicy fruit. Samples were sent to this Department and proved quite distinct from any fruit now known in the Colony, but the Ceylon Department reported that seed of the variety had been obtained originally from British Guiana in 1917.

Its origin is therefore rather obscure, but when the trees at Hosororo bear it will be of interest to see how the fruit turns out in the country of its supposed origin.

The following list summarises the budded citrus planted at the station in 1933.

Budded Grapefruit.

Marsh	213 plants
Duncan	76 ,,
Florida Marsh	5 ,,
Pernambuco	2 ,,
Labuan	2 ,,
Walters	8 ,,
Foster	8 ,,
	314 plants

Budded Oranges.

St. Michael's Blood	6 plants
Late Summer	5 ,,
Jaffa	8 ,,
T. H Late	9 ,,
Dancy Tangerine	16 ,,
Lue Gim Gong	10 ,,
Ruby	11 ,,
Parson Brown	10 ,,
Pineapple	9 ,,
Homosassa	3 ,,
Navel	14 ,,
Valencia	12 ,,
Satsuma	1 plant
Grenada Orange	4 plants
William Tangelo	1 plant
Sampson Tangelo	1 ,,
New Tangelo	1 ,,
Sunrise Tangelo	1 ,,
	122 plants

Budded Lemons, etc.

Ponderosa Lemon	4 plants
Sicily Lemon	3 ,,
Hybrid Lemon (Trinidad)	2 ,,
Succadee (Citron)	1 plant
	10 plants

Limes—budded and seedling.

Budded Limes—local	......	168 plants
„ —W.I. Smooth-skinned (St. Lucia)		24 „
„ —Hybrid (Dominica)		2 „
„ —Spineless	......	1 plant
Seedling Limes—Local	......	168 plants
		363 plants

The following varieties have also been established in the south-west field subsequently :

King Orange	......	......	5 plants
'Pink' Marsh grapefruit		......	3 „
Citropsis schweinfurthii		......	1 plant
Swinglea glutinosa		......	1 „
Murraya exotica		......	1 „
Clement Tangelo		......	1 „
Lake Tangelo	......	......	1 „
Minneola Tangelo	......	......	1 „
Smooth-skinned lemon (Surinam)		......	6 plants
Large thin-skinned lime (Dominica)		......	3 „
			23 plants.

Planting and Cultivation. All the budded citrus, with the exception of a few trees in the south-west field on rough lemon, was on sour orange stock. The planting distance was 25′ x 25′ except in the south-west field, where the trees were spaced 30′ x 30′. A few of the trees settled too low in the soil after planting, which condition however, was easily rectified by inarching with sour orange stock. Very little pruning was done to the young trees. It subsequently became apparent that the only areas of good soil were at the east end of the first field, where part of the Botanic Gardens Marsh is planted in a 'pocket' on the hill-side in which the soil is fairly deep, and in the lime field. Elsewhere, the soil is for the most part shallow and often very gravelly, with many outcrops of rock, and the growth of the plants has been poor—in some cases very poor. On some of the steeper slopes contour drains were dug to stop further erosion and the edges of these planted with Khus-khus Grass (*Anatherum zizanoides*), but only on the better soil under the Botanic Gardens Marsh was it possible to establish a cover crop—*Calopogonium mucunoides.* Throughout the cultivation a certain amount of supplying was necessary, subsequent to the original planting.

In the Botanic Gardens Marsh plot the trees made good growth, but as they developed, it was apparent that for the vigorous growth made in this area, they had been planted too close and also, partly owing to lack of shaping at the outset, they had become very woody and required drastic pruning, which was carried out in 1938 and 1939.

Manurial Treatment. In 1933 rows 1-15 of the Trinidad citrus and the Botanic Gardens Marsh in the first field were given a dressing of artificial manures consisting of ½ lb. potash, 1 lb. rock phosphate, 1 lb. superphosphate and 1 lb. sulphate of ammonia per tree.

In 1938 it was decided to give two dressings of artificials, one at mid-year and one at the end of the year to about half of the oranges west of the mahogany belt, and half the Duncan grapefruit and also to the miscellaneous citrus varieties in the south-west field. Each dressing consisted of 2 lb. potash, 1 lb. superphosphate and ½ lb. sulphate of ammonia. By May 1939, the oranges and miscellaneous citrus varieties, all of which were planted on very poor soil, had shown some response to the treatment in increased vegetative growth. In the case of the oranges which were on very gravelly ground, new soil also was placed over the roots of the plants. There has as yet been no noticeable response shown by the Duncan grapefruit, as the trees treated were already growing quite vigorously, but the coming crop (1939-40) should benefit. The dressings are being repeated on all these trees in 1939.

Fruiting—Production :

Oranges and Grapefruit. The Botanic Gardens Marsh bore a little fruit in 1933 and in 1934 the trees began to come into full bearing. The 1935-36 crop was a fair one and the 1936-37 crop a very big one. In 1937-38 the crop was less, and the 1938-39 crop was very poor, partly owing to the destruction of blossom by the abnormal rains of 1938 and also owing to the very heavy pruning given to the trees in that year. The grapefruit crop is from November to April; the orange crop begins rather earlier and is usually over by March.

The following table shows the crops that have been obtained at Hosororo.

TABLE.

Orange and Grapefruit Yields at Hosororo.

	1934–1935	1935–1936	1936–1937	1937–1938	1938–1939
Grapefruit,					
Varieties from Trinidad	1,211	3,505	4,836	5,088	1,196
Botanic Gardens Marsh	8,382	12,553	34,646	20,314	5,302
,, ,, Walters	5	45	162	408	494
,, ,, Duncan	97	549	1,212	1,434	1,806
S.W. field, Marsh	—	33	161	1,162	1,168
Total	9,695	16,685	41,017	28,406	9,966
Oranges.					
Varieties from Trinidad	7,289	4,545	11,092	8,732	2,988
Botanic Gardens Oranges	43	304	1,072	1,222	878
Total	7,332	4,849	12,164	9,954	3,866

Looking at the yields of individual trees it is found that these vary very considerably. In the Botanic Gardens Marsh section during the 1936-37 crop a few trees bore over 1,000 fruits, but the average per tree was only 280, since a number of the trees on patches of poor soil bore little or nothing. Amongst the plants from Trinidad the average crop of oranges per tree in the 1936-37 crop was only 258 fruits, though a few individual trees bore six or seven hundred fruits.

Limes. The limes bore a small crop in 1932 when 3 years old, the 2½ acres of 'seedlings' giving 5 barrels and the 2½ acres of budded plants yielding 17½ barrels, showing clearly the value of budding to give quicker bearing. Subsequently also the sour orange root system appeared to give better support on the very steep hillside where the limes were planted. A number of the trees on their own roots were blown over.

By 1934 the budded limes gave 202 barrels and the 'seedlings' 56 barrels, but in 1935 the crop was a very short one, yielding only 99 and 40 barrels respectively. In 1936 the crop was sold to the lime factory in the district; 210 barrels were obtained from budded and 'seedling' plants together. In 1937 the crop was good and 400 barrels were obtained from the whole field. The 1938 crop was poor, owing to damage by continual rain.

Fruiting—Quality :

Oranges and Grapefruit. As regards the quality of the fruit, it has tended throughout to be coarse, and sometimes rather lacking in juice. The grapefruit are large and often thick-skinned, though this latter feature was more marked at the first bearing than latterly. It is probable that the high rainfall is largely responsible for this coarse appearance, despite which the fruits have a good flavour. A sample of 400 Marsh grapefruit sent to the British Guiana Fruit and Canning Company in 1935 for trial canning gave fairly promising results. Some of the oranges, especially the Parson Brown, tend to bear dry fruit, though by picking this fruit early a certain amount of juiciness is retained.

A number of the Botanic Gardens Marsh trees were found to be bearing fruit with a good deal of seed in it, either due to the budwood used in propagation or to crossing having taken place with some of the many other varieties of citrus in the orchard, with some of which occasional cross-pollination may be possible. The degree of seediness may vary considerably from year to year in individual trees but the worst trees were cut back in 1938 and top-worked with scions from a Marsh tree of known good quality (one of the original Trinidad plants). It was found that if the whole tree were cut back to a stump, scions crown grafted on to this 'took' very readily.

Chemical Analysis of the Grapefruit Cultivation. In 1935 the Chemist analysed samples of leaf, fruit and soil from the Marsh grapefruit cultivation at Hosororo, taking samples from healthy trees, bearing well, and also from stunted trees, which bore little or no fruit and showed a tendency to appear

chlorotic *. It was concluded from the leaf analyses that the "low values "for total ash suggested the need for fertiliser applications. The divergent "values for the various nutrient ratios indicate that the balance of nutrients "requires adjustment by correct manuring. A comparison of the values obtained "from the healthy and unhealthy trees indicates the value of lime in grapefruit "nutrition." The soil analyses showed the lime status of the good soil to be adequate, but the poor soil to be highly acidic. In the fruit analyses the sugar-acid ratio indicated that the quality was poorer than that of Trinidad grapefruit but compared very favourably with that of Puerto Rico, Florida and Texas. The phosphate content of the fruit was also relatively low. It was therefore decided to dress six unhealthy trees with 7 lb. limestone and 4 lb. basic slag per tree, and to give an application of 3 lb. of superphosphate to six of the healthy trees and note any effect on the quality of the fruit. This was done in the early part of 1936.

The results of these dressings were not very conclusive. Three of the limed trees lost their chlorotic appearance, but showed no other improvement and the remainder showed no response. The application of superphosphate appeared to improve the yields, especially on three of the trees, but no very noticeable change in the quality of the fruit was apparent. It may be noted that in other cases of yellowing of the citrus trees, application of pen manure had brought about a greener appearance. The possible effect of spraying with zinc sulphate on these trees is now also being tested. This chlorotic appearance is seen occasionally on the lime trees also, and may sometimes be correlated with the fact that the trees had been planted on a very stony piece of ground.

Diseases and Pests. As regards diseases, the citrus has remained healthy, with the exception of scab (*Elsinoe Fawcetti*), which is very troublesome on the sour orange stock in the nurseries. The chlorotic appearance assumed by some of the trees is generally to be correlated with a patch of poor and rocky soil where the plant is situated and such trees are occasionally attacked by ants at the root. (Ref. also the previous paragraph). In the south-west field the Marsh grapefruit suffered considerably during the first year or two of their growth from the destruction of flushes of young leaves by wild bees until their nests in the surrounding bush had been found and destroyed. It has also been necessary to be constantly on guard against Coushi ants, and trace and destroy their nests regularly. These insects did a good deal of damage to the young plants at the outset.

General Conclusions. The following general conclusions may be drawn from this experimental citrus cultivation :

(1) The lateritic hills of the district are well suited to citrus provided that areas are selected in which the soil has not been exhausted by Indian cultivation or eroded during previous clearing and that the necessary steps are taken after planting to avoid erosion and washing away of surface soil.

* Divisional Reports of the Department of Agriculture for the year 1935, p. 82.

(2) Where vigorous growth is expected planting distances should be at least 30′ x 30′ for grapefruit and 25′ x 25′ for oranges and care should be taken to shape the trees well at the outset.

(3) Selection of good budwood and the avoidance of mixing too many varieties in any one area are precautions to be taken to obviate the occurrence of seed in 'seedless' varieties. Sour orange stock appears to be well suited to local conditions, but precautions must be taken against 'scab' in the nursery.

(4) Due attention must be paid to removal of Coushi ants' nests, especially near a young plantation, and if tall forest surrounds the orchard, a watch may have to be kept for wild bees' nests.

(5) Although on virgin soil good crops would be obtained initially without application of artificials, the trees will respond to manurial treatment and this will be a necessity if the vigour of the trees is to be maintained.

(6) The high rainfall of the district is by no means ideal for citrus cultivation and tends to give too much vegetative growth and fruits which are large and somewhat coarse in appearance when judged by the standards demanded in European markets. The fruit however is of good flavour to meet the demands of the limited local market for fresh fruit and in addition appears to be well suited for canning or production of concentrated fruit juices.

Finally it may be noted that the station, in addition to supplying budded plants to citrus growers in the district, also furnishes a good number of plants for distribution from the Botanic Gardens and during the last 3 years has supplied 2,200 grapefruit and 2,300 orange buds for use in the Gardens' nursery.

Avocado Pears.

Varieties planted. In addition to the citrus, 4 rows of avocado pears (44 plants in all) were planted in June 1928 and May 1929 at the west side of the first clearing. They included grafted plants of the varieties St. Anne's, River, Trapp, St. Clair, Pollock and Rudder, obtained from Trinidad in 1928 and the local varieties Martin-Sperry and R. C. Lord, together with Munis, which were grafted at the Botanic Gardens in 1929; subsequently in 1930 two more plants of Trapp and another of St. Anne's were supplied from the Gardens and in 1934 two plants of Galvana and one of Nimlioh were obtained from Trinidad.

Manurial Treatment. The pears received a dressing of artificials in 1935 consisting of ½ lb. potash, 2 lb. superphosphate and 1 lb. sulphate of ammonia per plant. In 1938 they received two dressings, one at mid-year and the other at the end of the year, of 2 lb. potash, 1 lb. superphosphate and ½ lb. sulphate of ammonia. The crop in 1938 suffered from damage by heavy rain to the blossom, but the backward trees do not appear to have benefited to any great extent from the dressing.

Fruiting. The pears began to bear in 1932 but have not proved satisfactory, and yields have been poor, though the best quality are undoubtedly the Pollock and Rudder varieties and St. Clair proved a good 'carrier'. The crop is on from July to September. Considerable damage is sometimes done to fruit on these trees by tiger cats.

Top-working. The local variety R. C. Lord gave the strongest vegetative growth on the very rocky soil in this part of the field, and two trees of this have been cut back to a stump and after allowing new shoots to spring again these have been grafted by 'approach' with scions of Rudder and Pollock, the scion being kept alive in a test tube of water tied to the stock until union took place. Attempts at cleft grafting failed.

COFFEE.

In 1928 the pegasse flat at the foot of the hill was cleared of Rubber and planted with Coffee—10 acres being devoted to Liberian and 5 acres to other varieties, namely *C. robusta, C. de Weveri, C. excelsa* and *C. stenophylla.* Bananas, maize, cassava and provisions, were also planted immediately after clearing, to shelter the young coffee. In 1929 further coffee species were added, including *abeokuta, canephora Pierre* and a Uganda variety of *robusta.*

All the coffee made very poor growth on the worn-out pegasse, and by 1934 the area under Liberian had been reduced to 2 acres for topping and pruning experiments and the other varieties were represented only by a bed of each. Eventually all these plants were abandoned, chiefly because all efforts to restore fertility to the worn-out pegasse had failed.

CACAO.

A small area was planted in 1929 on top of the hill with Cacao raised from pods of two types (labelled A & B) collected by the Director of Agriculture from trees of historical interest on the site of an old Dutch plantation at Kumaka on the Berbice River *. The trees there represented a mixture of Criollo and Forastero types and bore very good quality cacao. The resulting trees at Hosororo, 22 from type A and 15 from type B, have also borne pods of good quality cacao, which has been used chiefly as a seed supply for farmers in the district. There is a certain local demand for cacao, and cultivation has been extended in the North West District, where up to the present Witch Broom disease has not appeared.

FISH POISONS.

In 1928 the Black and White Haiaris, and some of the other fish poison plants used by the Aboriginal Indians were being considered as possible sources of insecticides, and experimental plots were planted consisting of ½ acre of Black and White Haiari (known then only as species of *Lonchocarpus*) under shade, *i.e.*, in bush which had been underbrushed. The planting distance was 3′ x 3′. Smaller areas also were established of Conami (*Clibadium*

* Agric. Journ. of B.G. II, p. 76, 1929.

surinamense), Conaparu (*Euphorbia cotinoides*), Daucanani (*Phyllanthus conami*) and Yarroconalli (*Tephrosia toxicaria*). An attempt to establish Hebitchioahabu (*Serjania* sp.) failed.

Analysis of these plants at Rothamsted showed however that only the Haiaris and Yarroconalli were likely to be of commercial value, and the latter proved difficult to cultivate, requiring a lot of atttention, so that in the end experimental cultivation was confined to the Haiaris. In 1931, another one acre each of Black and White Haiari were established under shade and a similar area in the open, on cleared ground. Both varieties made very good progress in the open, though growing slowly under the shade. In 1930 the original Haiari plot suffered some damage from a dipterous fly, and subsequently a leaf spot was found on all the Haiaris, especially under shade, but it appeared to do no serious damage. The analyses made periodically however showed a poor rotenone content (less than 3 per cent), which has been explained latterly by the botanical identification of the Haiaris, showing them to be two different species of Lonchocarpus (White, *L. Martynii* and Black, *L. chrysophyllus*)—quite distinct from the species of the Amazon basin (cubé and barbasco) which have a high rotenone content.

In 1934 and subsequently the Haiari plots were no longer weeded and were left to themselves. The plants in the open had made sufficiently vigorous growth to be able to hold their own with the 'bush' plants that sprung up, but had they been required for use in any quantity would have had to be kept clean, as the digging out of the roots—which contain a higher proportion of rotenone than the stems, is extremely difficult if those of the Haiari are mingled with roots of other plants.

The trees under shade slowly found their way up towards the canopy, and by 1938 had assumed their true liana or 'bush rope' habit, the climbing stems having in many cases a diameter of 2″ to 2½″.

A small plot of *Derris elliptica* was planted recently on the laterite, but it does not thrive there as successfully as on the clay at the Botanic Gardens.

Oil Palms.

In 1932 a selection of oil palms raised from seed obtained partly from palms at Onderneeming and partly from selected trees in Nigeria was planted on the pegasse flat at the hill foot, three hundred and twelve plants in all. These palms caught well and made good growth and have now begun fruiting, but already some have begun dying out as their roots get down to water and the remainder will probably suffer subsequently in the same way.

Miscellaneous Crops.

Spices. A few trees of Nutmeg, Cinnamon and Tonka Beans were planted. None proved markedly successful.

Citronella. The pegasse flat between the oil palms was planted with 2½ acres citronella in 1934 (4′ x 4′) seed having been obtained from Ceylon the previous year. The grass grew very vigorously, but the oil obtained has been

of disappointingly poor quality. Recently this grass has been planted on the hill and oil from this source has still to be sampled.

Pepper. A small plot of Black Pepper—*Piper nigrum*—including a plant of the variety Balamcotta, was planted on the hill top in 1931, using plants of *Glyricidia maculata* to support the pepper vines. The site proved unsatisfactory and in 1935 the pepper was transferred to the hill foot, where it has also given poor results.

Tung Oil. A few plants of *Aleurites montana* and *A. fordii* were planted on the laterite in 1935. *A fordii* failed entirely but *A. montana* has grown fairly well and began fruiting this year. It is to be extended.

Panama Hat Palm (Carludovica palmata), has been grown for some years in a small plot on the hillside, below the station. It grows quite well, but there is at present no demand for the fibre.

Ginger and Turmeric. The Jamaica, Canton and Dominican varieties of ginger were grown at the Station, and also turmeric. The Dominican variety of ginger failed but the Canton and Jamaica varieties grew fairly well on the laterite. They have served as a source of distribution to farmers in the district, and ginger has been cured at the station of a quality undoubtedly better than that generally imported into the Colony. At present, however, the price paid in Georgetown does not attract the farmers to prepare this article and they are satisfied with supplying the limited local market for green ginger. Also the frequent rainfall is inimical to successful curing.

Ginger Lily. (*Hedychium coronarium*). Attempts to cultivate this plant on a plot of land by the creek, at the hill foot, have not been very successful, since the brackish nature of the water in the creek (which is tidal) prevents its use for irrigation, which is necessary to obtain well-grown plants of ginger lily. The cultivation of this crop has been carried out in response to various requests from persons abroad who are interested in the plant as a source of fibre and require data as to costs of production and yields. Sample bales of dried stems have been supplied to manufacturers and though analysis of the fibre has indicated it to be of poor quality, it is possible that it could be used in certain classes of manufacture. It is difficult however to obtain optimum growth of the plant under artificial conditions. In nature the plant grows most vigorously on banks at the margin of fresh water rivers and creeks where the base of the plant is alternately covered and exposed by the rise and fall of the tide.

Cherimoyer. *(Anona cherimolia).* Attempts to grow this on the laterite failed entirely.

Castor Oil. (*Ricinus communis*). Plants of this also proved unsuited to the laterite.

Hydnocarpus anthelminticus grew moderately on the laterite.

Azadirachta indica, the Neem, was not successful.

Pineapples and *Crowa Fibre* were cultivated near the citrus orchard. They came to very little, owing to the poorness of the soil. *Crowa* and *Malachra capitata* were also tried on the pegasse flat, but with no success. *Ramie* or *China Grass* (*Bohemeria nivea*) was also a failure.

British Honduras Mahogany—Swietenia macrophylla—close planted as a windbreak in the citrus orchard, came away well and has grown fairly satisfactorily. The bark suffered some damage from the attacks of larvae of a species of *Hypsipyla*.

Soya Beans were tried on both the laterite and the pegasse flat without success.

Jerusalem Artichokes were grown (in 1929) with some success on the pegasse, and small plots of *onion* and *cabbage* were planted at the same time.

Yams and *Corn*, tried on the hill in 1929 and 1930, were not very successful. The best yield of corn was at the rate of 18 bags to the acre (@ 180 lb. per bag = 3,240 lb. per acre) and of yams at the rate of 11,000 lb. per acre.

Fodder Crops. Elephant Grass, Uba Cane and Wynne Grass were grown from 1928—1930 for distribution to farmers.

Legumes and *Green Manures.* Sunn Hemp and *Phaseolus semi-erectus* were introduced in 1928 without success. Attempts made in 1932 to restore some degree of fertility to the worn pegasse soils by growing green manure crops on them failed entirely. Several legumes, including Sword Bean, were also tried as a cover crop under the citrus, and eventually by 1935 *Calopogonium mucunoides* became established in those areas where the soil had not suffered seriously from erosion.

WAUNA.

DESCRIPTION OF THE SOIL.

This area also had for long been the site of Indian cassava cultivations, the sandy hills being preferred to the laterite as they are generally more readily accessible.

Follett-Smith describes the sandy hill soils, of which Wauna is representative, as follows (*loc. cit.* p. 23). "The soils are acid sands of low organic "matter content overlying a slightly heavier acid subsoil which contains a "smaller amount of organic matter. All samples are markedly deficient in lime, "and in both available and total phosphoric acid. The available potash supply "of the topsoils is fair, that of the subsoils low. The potential supply of potash "in all cases is low." Such soils were obviously relatively infertile and their value largely dependent on their humus content, and the main object of the Station was to find whether this could be maintained and any permanent crops raised on such sites. The average rainfall at Wauna since 1933 has been 112 inches.

THE CROPS CULTIVATED.

CITRUS.

Varieties planted. In 1931 four acres of citrus were planted, spaced 30′ x 30′, consisting of the following :

On Rough Lemon Stock—

20 Parson Brown Orange
5 Navel Orange
13 Valencia Orange
5 Dancy Tangerine
42 Marsh Grapefruit

On Sour Orange Stock—

42 Limes
45 Marsh Grapefruit
4 Navel Orange
5 Valencia Orange
12 Parson Brown Orange
3 Dancy Tangerine
2 Succadee (Citron) Seedlings.

A certain amount of supplying was subsequently necessary. In 1933 six Tangelo plants and five King Orange were also added, but were transplanted to Hosororo in 1935.

Stocks. Although growth in general was poor, the rough lemon stocks appeared rather better suited to these sandy soils than the sour orange.

Manurial Treatment. In 1933 all the citrus with the exception of the limes received a dressing of artificial manures. ½ lb. potash, 1 lb. rock phosphate, 1 lb. superphosphate and 1 lb. sulphate of ammonia was applied to each of the older trees and 1 lb. of a similarly proportioned mixture to the newly planted King Oranges and Tangelos. In 1935 the grapefruit, oranges and tangerines were again manured with ½ lb. potash, 2 lb. basic slag and 1 lb. sulphate of ammonia per tree. The trees, except the limes, made very slow progress and many were still very small even after six years' growth.

Fruiting. By 1934 the limes were fruiting fairly well, but the other citrus had borne little or no fruit. In 1935 a little fruit was borne, but of poor quality and with little juice in it. By this time it had become apparent that, at any rate by the ordinary methods of the farmer, citrus crops could not be produced on the station, and the field was partially abandoned, weeding being continued only around the base of each tree.

Fish Poison Plants.

In 1930 four acres were planted with Black and White Haiari spaced 3′ x 3′ and two acres with Yarroconalli. The former were planted half in the open and half under shade, as at Hosororo. The Yarroconalli again failed to become established.

The Haiaris fared much as at Hosororo, though the growth at Wauna was rather better, especially in the open. The White Haiari flowered and fruited in the open in April 1935, giving viable seed. It was at first identified as *Lonchocarpus nicou* (Aubl.) DC. but later found to be a new species named

L. Martynii *. The Black Haiari is considered to be *Lonchocarpus chrysophyllus* Kleinh, but has never flowered in cultivation. Since 1936 no weeding has been done and the plants have been left to themselves. By 1938 those under the trees had assumed a liane habit as at Hosororo.

OIL PALMS.

In 1932 three acres were planted with oil palms raised from seed obtained at Onderneeming and also from selected Nigerian palms—136 plants in all. Since 1936 little or no weeding has been carried out on this section, but the palms have grown quite vigorously and are now beginning to bear fruit.

COCONUTS.

In 1932 three acres were planted with coconuts, nuts being taken from selected trees in Wakenaam Island and the Moruca district, and 17 St. Lucia Dwarf Red Coconuts were also put out. All these have made very slow growth. The Dwarf Coconuts were manured in 1934 and again in 1935 with a dressing of ½ lb. potash, 1½ lb. sulphate of ammonia and 1 lb. superphosphate per tree. They showed little response however, and to date only one tree has borne a few fruits.

MISCELLANEOUS.

Arabian Coffee. In 1930 one acre was planted with this crop but it proved of no use at all.

Wynne Grass. (*Melinis minutiflora*). A small patch of this was planted in 1930 and has spread widely, now completely taking over the adjacent area to an extent of several acres.

Mesquite. (*Prosopis juliflora*). A few plants of both a thorny and a thornless variety of this were planted in 1933, but the sand proved too hot for them and they failed to become established.

Cover Crops. Attempts to establish these were not successful, although *Calopogonium mucunoides* made some progress under the citrus.

GENERAL CONCLUSIONS.

It is apparent that it is not possible to restore or maintain fertility from the point of view of crop production in these sandy soils, once it has been lost, by any methods within the economic range of the average farmer. The only major crop that appears to make headway on this poor land is the oil palm, but it remains to be seen whether their yields under such conditions will be worth while. The Wynne Grass on the other hand appears to promise value both as a cover and a forage crop, though its behaviour under grazing has not been studied. Wauna shows very clearly the extreme importance of conserving the humic layer in these light soils from the time of their first clearance from forest, admittedly a speculative proposition, even under the most careful and intensive management.

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* Divisional Reports of the Department of Agriculture for the year 1937, p 81, paragraph 6.

THE VARIETY AND FERTILISER POSITION OF THE SUGAR INDUSTRY, V.

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ESTATE YIELDS.

The Managers of the Colony's sugar estates have kindly supplied statistics of the commercial yields obtained in 1938. Of the widely planted canes, P.O.J. 2878 was the best yielder, Diamond 10 next and D. 625 last. The data for these varieties are condensed and combined with those of previous years in Table I, where the weighted mean yields for the past five years are given. Since Table I is derived from data for five years and many thousands of acres, considerable reliance can be placed on the relative order of merit of the three canes and there is obviously much support for the policy, generally adopted, of eliminating D. 625 and the growing tendency to extend P.O.J. 2878 at the expense of Diamond 10.

TABLE I.

Weighted Mean Yields of 96° Sugar per English Acre from the Major Varieties Grown in British Guiana During 1934-1938.

		FRONTLAND SOILS			PEGASSE SOILS.		
		P.O.J. 2878	Diamond 10	D. 625	P.O.J. 2878	Diamond 10	D. 625
Plant Canes	Acres reaped:	14,457.9	28,676.9	25,418.8	5,143 4	4,040.3	2,572.7
	Yield of sugar per acre, tons:	3.87	3.59	3.37	3.34	3.56	3.50
First Ratoons	Acres reaped:	8,343.2	23,945.0	31,901.7	3,652.7	4,003.5	3.937.8
	Yield of sugar per acre, tons:	3 60	3.15	3.01	3.31	2.95	2.82
Second Ratoons	Acres reaped:	3,925.7	16,466 9	32,216.4	1,678 0	2,406.2	3,772.9
	Yield of sugar per acre, tons:	3 31	3 02	2 65	2.88	2.63	2.68
Three Crops	Total Yield of sugar per acre, tons:	10.78	9.76	9.03	9.53	9.14	9.00

VARIETAL COMPOSITION OF THE 1939 HARVESTS.

Table II is compiled from the returns supplied by the estates and shows, together with Figure I, the relative importance, by area, of the varieties to be harvested in 1939.

TABLE II.

Percentage Distribution of the Varieties to be Reaped During 1939.

Variety.	Total English Acres in the Colony.	Percentage in West Demerara.	Percentage along Demerara River Banks.	Percentage in East Demerara.	Percentage in Berbice.
P.O.J. 2878	28,232.36 (45.7%)	11.8	8.0	33.4	46.8
Diamond 10	26,864.84 (43.5%)	20.6	38.5	18.5	22.4
D. 625	4,938.37 (8.0%)	...	6.7	26.9	66.4
Other canes	1,250.73 (2.0%)	36.8	46.7	2.7	13.8
Mixed	521.66 (0.8%)	...	79.9	0.3	19.8
	61,807.96 (100.%)				

The areas in both P.O.J. 2878 and Diamond 10 have expanded, but the former much more rapidly and the Java cane now covers a larger area than does the Diamond. D. 625 is disappearing rapidly and 'mixed' areas have been almost entirely eliminated. Table III shows the changes, in regard to the areas under P.O.J. 2878, Diamond 10, D. 625 and 'mixed' only, which have taken place in recent years.

TABLE III.

Comparison of Areas of D. 625, Diamond 10, P.O.J. 2878 and "Mixed" in the Colony During Recent Years.

Variety.	Per Cent. of Total Area in the Colony.					
	1934	1935	1936	1937	1938	1939
D. 625	62.5	55.4	44.6	33.0	20.6	8.0
Diamond 10	16.8	22.7	29.4	36.6	41.3	43.5
P.O.J. 2878	1.4	4.7	9.7	19.2	31.7	45.7
"Mixed"	9.5	12.6	12.7	8.8	4.0	0.8

COMMERCIAL TESTS WITH NEW VARIETIES.

From all points of view it is desirable that the varieties which show up in the Department's variety trials be extended and tried out on a small scale, under commercial conditions, as rapidly as possible. This is a valuable and almost

PLATE II.

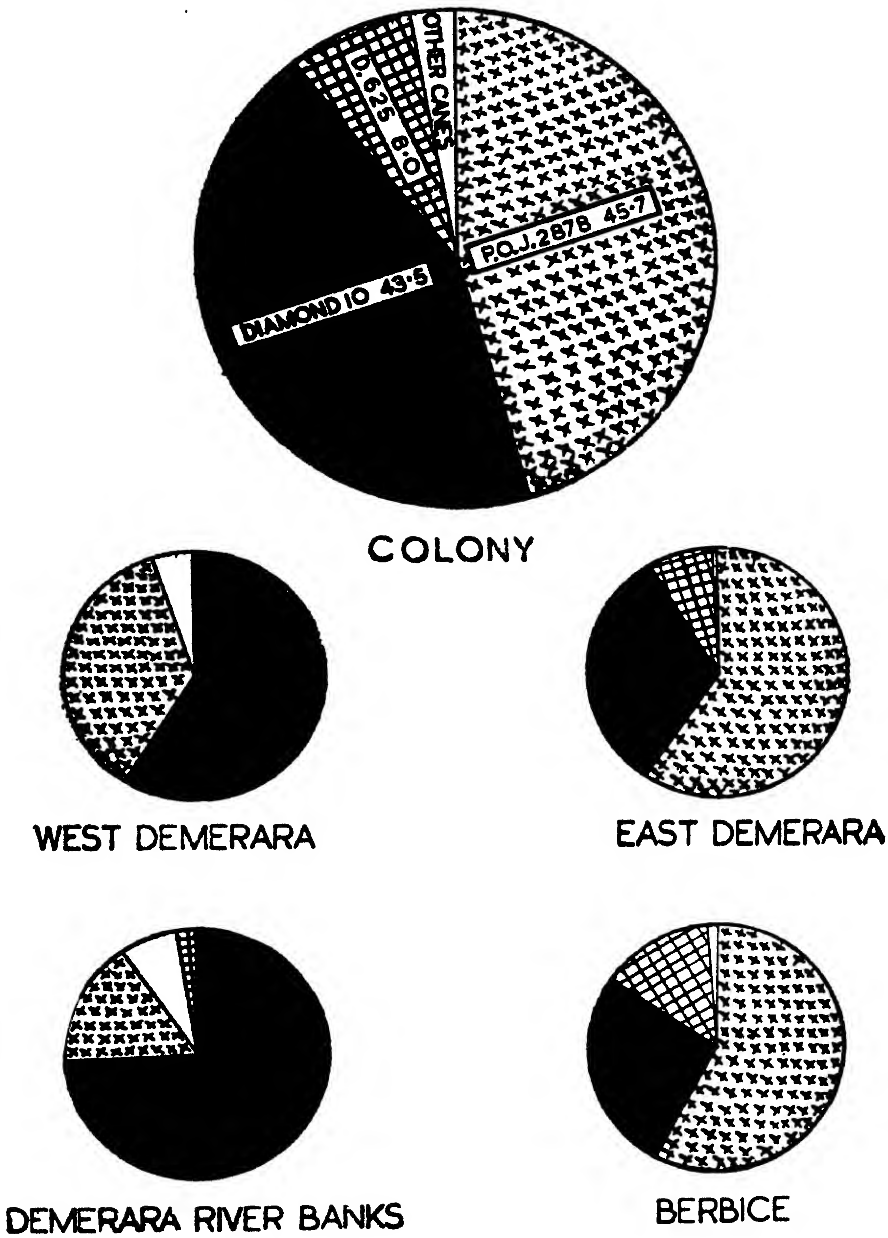

FIG. I.

Relative Varietal Composition of the Cane Areas to be harvested in British Guiana in 1939

PLATE III.

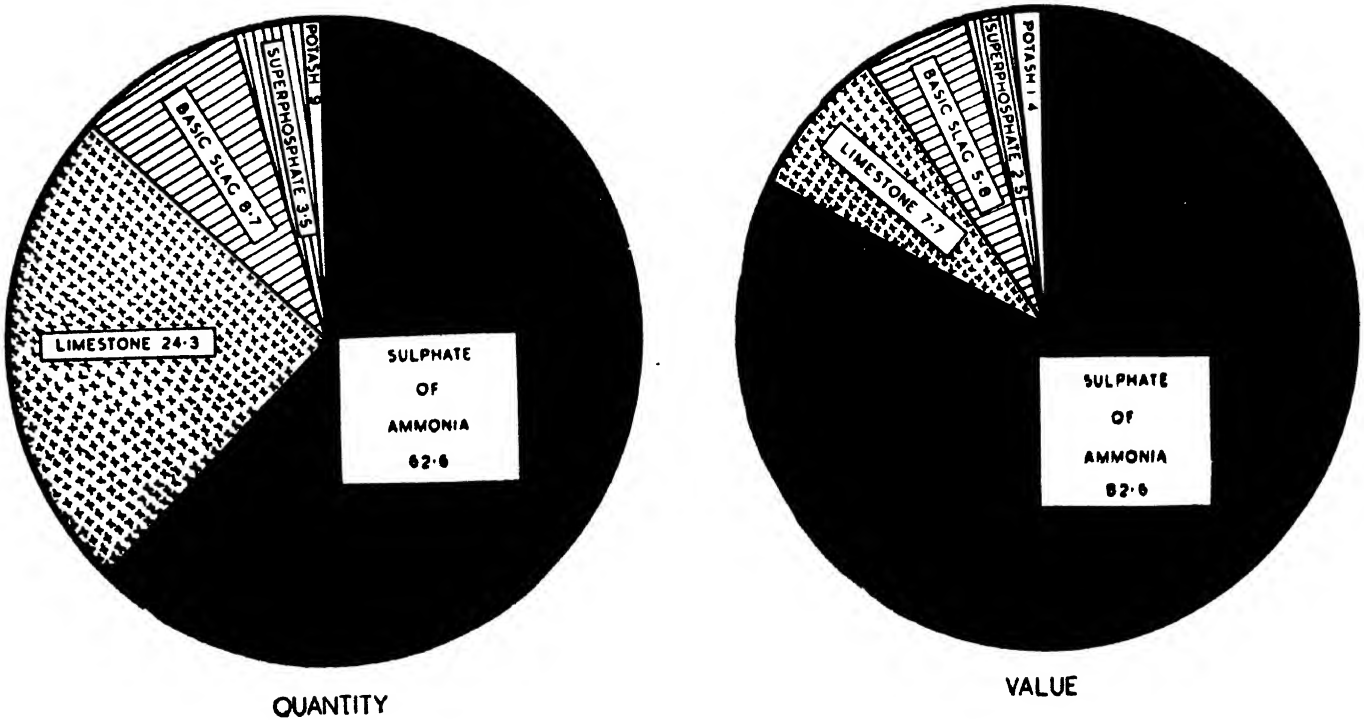

Fig. II.
Relative Quantities and Values of Fertilisers used on British Guiana Sugar Estates in 1938.

indispensable adjunct to the experimental work and can yield much information regarding such factors as weed control, ease of harvest, loading and milling, quality of bagasse, adaptability to various soils, etc. It is recognised that the establishment of odd fields of almost unknown varieties and the upkeep of their records involve a considerable amount of trouble, some risk of a slightly reduced yield, and, possibly, certain additional expense, but it is in the interests of all concerned that each estate bear a portion of the burden. While some are still hesitant, it is gratifying to record that most Managers have now initiated some work of this nature. In consequence, an increased volume of information from this source may be expected in future. In the meantime, the following notes, culled from the reports of pioneers in this line, will be of interest.

D. 835/18

This cane has been tried at Pln. Skeldon in three fields planted, respectively, in 1933, 1934 and 1935. The total area involved was about 25 acres, and the average yields of sugar per acre were :—

	Plants.	First Ratoons.	Second Ratoons.	Third Ratoons.	General Average.
Tons sugar per acre	3.96	3.73	3.14	2.85	3.42

At Pln. Rose Hall, 2.6 acres of second ratoons averaged 2.48 tons of sugar per acre in 1933, and, in 1934, 5.44 acres of third ratoons averaged 3.19 tons.

A quarter of an acre was planted at Pln. Blairmont in 1934 but the returns were not encouraging.

D. 602/22

This seedling has been repeatedly tried at Pln. Versailles and has given satisfactory yields there on the unkindly pegassy clay. Indeed, the Manager recently reported : " D. 602/22, I consider worthy of extending on any land."

At Pln. Skeldon, three acres of third ratoons averaged 3.17 tons of sugar per acre in 1936, and four acres of first ratoons averaged 3.57 tons of sugar per acre in 1934.

At Pln. Blairmont, yields from a few small patches (half to one and a half acres) have not been impressive.

D. 927/22

An eleven-acre field has been carried through a four-crop cycle at Pln. Port Mourant. The juice purities were somewhat low, but, as will be seen below, yields were quite satisfactory :—

	Plants.	First Ratoons.	Second Ratoons.	Third Ratoons.	General Average.
Tons sugar per acre	3.36	3.62	4.24	3.71	3.73

D. 11/28

This seedling has been tested at Pln. Skeldon and, to a lesser extent, at Pln. Port Mourant. The average yields from 13.4 acres of plants and 14.7 of first ratoons were :

	Plants.	First Ratoons.
Tons Sugar per acre	3.58	3.39

D. 49/30

Tried at Plns. Providence (Berbice and Demerara) and Skeldon, this seedling averaged 4.56 tons sugar per acre from a total of 11.5 acres of plant canes. At Pln. Skeldon, 4.5 acres of first ratoons yielded 3.58 tons sugar per acre, but at Pln. Providence (Berbice) a small patch (1.3 acres) of first ratoons only averaged 1.18 tons sugar per acre. In these tests the cane was generally of high quality.

D. 66/30

A considerable number of tests with this variety are reported from Plns. Skeldon, Port Mourant, Albion, Providence (Berbice and Demerara), Blairmont, Bath, Cane Grove, La Bonne Intention, Diamond, Wales and Versailles. It appears to thrive at Skeldon where it has averaged 5.09 tons sugar per acre from 40.5 acres of plants and 3.80 tons from 22 acres of first ratoons. Good plant cane results have been secured at Diamond, Providence (Demerara) and Wales, but the data from other points are not encouraging and the first ratoons at Providence (Berbice), Cane Grove and Wales were disappointing.

D. 75/30

At Pln. Leonora this cane averaged 4.95 tons sugar per acre from a 2.6 acre plot. The cane was of good quality.

Co. 213

Plns. Skeldon, Albion, Providence (Berbice), Blairmont, Cane Grove and Lusignan have been testing this cane. On 33.6 acres of plant canes it averaged 3.48 tons sugar per acre, and on 30.1 acres of first ratoons it averaged 3.27 tons. At Cane Grove, 3.0 acres of second ratoons yielded 2.29 tons of sugar per acre.

FERTILISERS IN 1938.

In Table IV., the fertiliser imports for 1938 are compared with those of recent years, the data being adapted from the Reports of the Comptroller of Customs.

The quantities imported and the expenditure on all groups of fertilisers fell, as compared with 1937, a record year. With the quota restrictions following the international sugar agreements, this was to be expected.

The estates have kindly supplied details as to the various manures used in 1938, and the data for 1936 to 1938 are summarised in Table V. Figure II is a graphical presentation of the 1938 returns. It should be noted that pulverised limestone has gradually replaced lime and that the imports of superphosphate are declining steadily.

TABLE IV.

Fertilisers Imported into British Guiana in Recent Years.

Year.	Nitrogenous Fertilisers (almost entirely Sulphate of Ammonia).			Manurial Lime (including Limestone).			Other Fertilisers (mainly Superphosphate and Basic Slag with some Sulphate of Potash).			Total Imports.	
	Tons.	Value $	Value per Ton, $	Tons.	Value $	Value per Ton, $	Tons.	Value $	Value per Ton, $	Tons.	Value $
1926	6,691	403,407	60.29	2,806	32,952	11.74	2,072	42,100	20.32	11,569	478,459
1927	7,271	393,084	54 06	3,507	40,777	11 63	3,871	94,826	24.50	14,649	528,687
1928	6,721	359,526	53 49	3,766	41,290	10 96	2,277	47,139	20.70	12,764	447,955
1929	6,693	358,231	53.52	2 560	26,051	10.18	2,971	71,189	23.96	12,224	455,471
1930	7,207	316,158	43.87	2,754	27,394	9.95	2,624	62,069	23.65	12,585	405,621
1931	7,165	249,107	34 77	3,239	32,984	10 18	3,226	83,460	25.87	13,630	365,551
1932	8,294	254,726	30.71	4,366	42,071	9.64	2,619	54,281	20 73	15,279	351,078
1933	7,681	263,456	34.30	4,749	42,569	8.96	2,937	76,617	26 09	15,367	382,642
1934	7,727	248,185	32.12	4,306	38,524	8 95	2,168	48,735	22.48	14,201	335,444
1935	10,268	333,732	32.50	4,917	39,521	8.04	3,096	60,812	19.64	18,281	434,065
1936	9,963	334,556	33.58	3,786	28,453	7 52	2,639*	52,092*	19.74	16,388	415,101
1937	11,171	367,689	32.91	4,537	33,342	7.35	2,537*	49,509*	19 51	18,245	450,540
1938	10,205	356,068	34 89	3,755	27,131	7.23	2,199*	46,821*	21.29	16,159	430,020
Mean	8,225	325,994	39.59	3,773	34,851	9.24	2,710	60.742	22.41	14,719	421.587
% of Mean Annual Imports:	55.95	77.33		25.64	8.27		18.41	14.41			

*Includes { 1936: 152 tons of Sulphate of Potash, valued at $ 6,652 or $43.76 per Ton.
1937: 160 " " " " " " $ 6,929 or $43.31 per Ton.
1938: 234 " " " " " " $10,196 or $43.57 per Ton.

TABLE V.

Values and Quantities of Fertilisers used on British Guiana Sugar Estates, 1936—1938.

Fertiliser.	$			Per cent. of Total Expenditure			Per Ton $			Tons.			Per cent. of Total Imports.		
	1936	1937	1938	1936	1937	1938	1936	1937	1938	1936	1937	1938	1936	1937	1938
Sulphate of Ammonia	395,970.73	375,273 90	410,057.89	79.3	79.1	82.6	37.75	38.16	40.15	10,487.97	9,834.65	10,212.47	62.4	60.2	62.6
Lime	11,166.60	6,861.58	...	2 2	1.4	...	11 58	11.55	...	964.30	593.92	...	5.7	3.6	...
Basic Slag	38,302.14	34,465.03	28,905.38	7.7	7.3	5.8	21.61	21 58	20.30	1,772.20	1,596.80	1,423.99	10.6	9.8	8.7
Superphosphate	17,897.38	13,960.48	12,166.14	3.6	2.9	2 5	23 52	20.62	21.54	761.00	676.92	564.85	4.5	4.1	3.5
Limestone	25,670 81	35,241.44	38,237.47	5.1	7 4	7.7	9.79	10 18	9.66	2,622.27	3,461.99	3,958 40	15.6	21.2	24.3
Sulphate of Potash	10,107.82	8,481.43	6,647 60	2.0	1.8	1 3	52.71	49.11	46.68	191.77	172 71	142.40	1.1	1.1	0.9
Miscellaneous	499.85	331.25	350.84	0.1	0.1	0.1	..	...	...	11.00	5.00	5.30	0 1	...	...
TOTAL ...	499,615.33	474,615.11	496 365 32	100 0	100 0	100.0	..	. .	...	16,810.51	16,341.99	16,307.41	100.0	100.0	100.0

CATALOGUE OF THE LEPIDOPTERA RHOPALOCERA (BUTTERFLIES) OF BRITISH GUIANA—*(Contd.)*

BY

ARTHUR HALL, F.R. Ent. S.

242. EUSELASIA EUPHAES.
(1854).
Eurygona euphaes, Hewitson, Ex. Butt. I, *Eurygona* t. 4, f. 38-40
Annai.

243. EUSELASIA ARBAS EUORAS.
Eurygona euoras, Hewitson, Ex. Butt. I, *Eurygona* t. 4, f. 38-40. (1854).
Potaro River.

244. EUSELASIA LISIAS.
Papilio lisias, Cramer, Pap. Ex. II, t. 152, F, G (1779).
Carimang River; Quonga; Annai; Nappi, Kanuku Mts.

245. EUSELASIA GELANOR.
Papilio gelanor, Cramer, Pap. Ex. IV, t. 336, C, D (1782).
Carimang River; Annai; Quonga; Mt. Roraima.

246. EUSELASIA CROTOPUS.
Papilio crotopus, Cramer, Pap. Ex. IV, t. 336, E. F., 390, G, H. (1782).
Carimang River; Mabaruma.

247. EUSELASIA LABDACUS.
Papilio labdacus, Cramer, Pap. Ex. IV, t. 336, G, H. (1782).

248. EUSELASIA EUGEON.
Eurygona eugeon, Hewitson, Ex. Butt. I, *Eurygona* t. 7, f. 62 (1856).
Omai; Quonga.

249. EUSELASIA EURYPUS.
Eurygona euboea, Hewitson, Ex. Butt. I, *Eurygona* t. 1, f. 4, 5 (1852).
Carimang River.

250. EUSELASIA CHELES.
Eurygona cheles, Godman & Salvin, Ann. Mag. Nat. Hist. (6), IV., p. 356 (1889).
Omai; Quonga.

251. EUSELASIA EUBOEA.
Eurygona euboea, Hewitson, Ex. Butt. I, *Eurygona* t. 1, f. 4, 5 (1852).
Annai.

252. EUSELASIA PELOR.
Eurygona pelor, Hewitson, Ex. Butt. I, *Eurygona* t. 1, f. 1-3 (1852).
Annai.

253. EUSELASIA TELECLUS.
Papilio teleclus, Stoll, Suppl. Cram. t. 5, f. 4, 4E (1787).
Demerara River; Carimang River; Potaro River; Mt. Roraima.

254. EUSELASIA URITES.
Eurygona urites, Hewitson, Ex. Butt. I, *Eurygona* t. 2, f. 19 (1852).
Mt. Roraima.

255. METHONELLA CECILIA.
Papilio cecilia, Cramer, Pap. Ex. II, t. 159, D, E (1779).
Annai; Quonga; Carimang River; Upper New River, (J. G. Myers, Dec. 1935).

256. HELICOPIS CUPIDO.
Papilio cupido, Linnaeus, Syst. Nat. I, p. 482, n. 145 (1758).

Locally abundant in swampy places under the sea or at the mouths of rivers. It is found in colonies amongst the tall plants of the mucca-mucca (*Montrichardia aculeata*) upon which the larva feeds. The butterflies settle on the under surface of the leaves with the wings closed and have a very feeble flight.

257. HELICOPIS LINDENI.
H. lindeni, Grote, Bull. Buff. Soc. II, p. 108, t. 2 (1874).

This is usually considered an aberrant or seasonal form of *H. cupido* but in December, 1929, I took *lindeni* at Craig Village near Georgetown and *cupido* at Parika on successive days, each form being constant and common in its locality. This seems to suggest that *lindeni* is either a separate species or else a good subspecies of rather remarkable distribution.

258. HELICOPIS ENDYMION.
Papilio endymion, Cramer, Pap. Ex. III, t. 244, C, D (1782).
Mabaruma. (Rare). Demerara River.

Sub-family ERYCININAE.

259. EURYBIA NICAEUS.
Papilio nicaeus, Fabricius, Syst. Ent. p. 482, n. 175 (1775).
Bartica; Quonga; Kaieteur Falls.

260. EURYBIA DARDUS.
Papilio dardus, Fabricius, Mant. Ins. II, p. 230, n. 324 (1787).
Demerara River; Mt. Roraima.

261. EURYBIA LAMIA.
Papilio lamia, Cramer, Pap. Ex. II, t. 150, C (1779).
A single specimen from Bartica in the British Museum.

262. EURYBIA HALIEMEDE.
Limnas subtilis halimede, Hubner, Samml. Ex. Schmett. (1806-16).
Potaro River (Coll. Kaye).

263. MESOSEMIA STELI.
M. steli, Hewitson, Ex Butt. II, *Mesosemia* t. 2, f. 13 (1858).
Annai.

264. MESOSEMIA EUMENE.
Papilio eumene, Cramer, Pap. Ex. I, t. 92, F, G (1779).
Demerara; Bartica; Carimang River; Kaieteur Falls; Mt. Roraima.

265. MESOSEMIA SIRENIA.
M. sirenia, Stichel, Berl. Ent. Zeit. 1904, p. 14.
Takutu.

266. MESOSEMIA MENOETES.
M. menoetes, Hewitson, Ex. Butt. II, *Mesosemia* t. 6, f. 56-58 (1859).
Annai; Quonga; Mt. Roraima. The specimens do not seem to be quite typical.

267. MESOSEMIA PHACE.
M. phace, Godman, Trans. Ent. Soc. 1903, p. 529, t. 20, f. 1.
Described from Mt. Roraima. Also from Quonga and Demerara River.

268. MESOSEMIA IBYCUS.
M. ibycus, Hewitson, Ex. Butt. II, *Mesosemia* t. 7, f. 68, 69 (1860).
Demerara; Bartica; Parika; Carimang River; Kaieteur Falls; Mt. Roraima. One of the commonest species.

269. MESOSEMIA CIPPUS.
M. cippus, Hewitson, Ex. Butt. II, *Mesosemia*, t. 6, f. 48, 49 (1859).
Demerara; Bartica; Carimang River; Kaieteur Falls; Mabaruma.

270. MESOSEMIA SYLVINA.
M. sylvina, Bates, Journ. Linn. Soc. Zool. IX p. 372 (1867).
Annai; Carimang River.

271. MESOSEMIA NINA.
Papilio nina, Herbst, Naturs. Schmett. IX, p. 30, t. 233, f. 1, 2 (1798).
Carimang.

272. MESOSEMIA CAPANEUS.
Papilio capaneus, Cramer, Pap. Ex. III, t. 236, D (1782).
Demerara River; Carimang River; Garraway Stream; Kuturi River.

273. MESOSEMIA METOPE.
M. metope, Hewitson, Ex. Butt. II, *Mesosemia* t. 7, f. 64, 65 (1860).
Annai; Carimang River; Potaro River.

274. MESOSEMIA PHILOCLES.
Papilio philocles, Linnaeus, Syst. Nat. I, p. 483, n. 155 (1758).
Demerara River; Quonga; Mabaruma; Kaieteur Falls; Mt. Roraima. A common species.

275. MESOSEMIA COEA.
M. coea. Hübner, Verz. bek. Schmett. p. 21, n. 146, (1816).
Demerara River; Berbice; Takutu; Mt. Roraima.

276. MESOSEMIA MELAENE.
M. melaene, Hewitson, Ex. Butt. II, *Mesosemia* t. 5, f. 54, 55 (1859).
Bartica; Kaieteur Falls.

277. MESOSEMIA PINGUILENTA.
M. pinguilenta Stichel, Deutsch. Ent. Zeit. 1905, p. 671.
Type in the British Museum from the Carimang River. Perhaps only another form of *M. melaene.*

278. MESOSEMIA METHION.
M. methion, Hewitson, Ex. Butt. II, *Mesosemia* t. 8, f. 76 (1860).
Quonga; Mt. Roraima.

279. MESOSEMIA MAERA.
M. maera, Hewitson, Ex. Butt. V, *Mesosemia* t. 12, f. 114, 115 (1873).
Bartica; Quonga; Potaro River; Carimang River; Mt. Roraima.

280. MESOSEMIA MACHAERA.
M. machaera, Hewitson, Ex. Butt. II, *Mesosemia,* t., 8 f. 70, 71 (1860).
Carimang River; Mabaruma; Mt. Roraima.

281. MESOSEMIA MAGETE.
M. magete, Hewitson, Ex. Butt. II, *Mesosemia,* t. 8, f. 72 (1860).
Carimang River; Kaieteur Falls; Mt. Roraima.

282. MESOSEMIA ARAEOSTOLYA.
M. araeostolya, Stichel, Deutsch. Ent. Zeit. 1915, p. 682, t. 21, f. 21.
Type in the British Museum from "British Guiana".

283. MESOSEMIA THYMETUS.
Papilio thymetus, Cramer, Pap. Ex. II, t. 148, G (1779).
Annai; Carimang River.

284. MESOSEMIA OREAS.
M. oreas, Stitchel, Deutsch. Ent. Zeit. 1915, p. 687.
Takutu.

285. DIOPTHALMA PHILEMON.
Papilio philemon, Cramer, Pap. Ex. I, t. 22, G, H (1775).
Mt. Roraima.

286. DIOPTHALMA IPHIAS.
D. iphias, Stichel, Berl. Ent. Zeit. 1909, p. 274.
Annai; Carimang River; Mt. Roraima.

287. DIOPTHALMA HYPHAEA.
Papilio hyphaea, Cramer, Pap. Ex. I, t. 92 C (1779).
Common in most forest districts.

288. PEROPTHALMA TULLIUS.
Papilio tullius, Fabricius, Mant. Ins. II, p. 34, n. 359 (1787).
Parika; Kaieteur Falls. Common where found.

289. HYPHILARIA NICIAS.
Papilio nicias, Stoll, Suppl. Cram. t. 13, f. 3 (1790).
Carimang River.

290. HYPHILARIA ORSEDICE.
H. orsedice, Godman, Trans. Ent. Soc. 1903, p. 531, t. 20, f. 5. Mt. Roraima; Kaieteur Falls.

291. EUNOGYRA SATRYUS.
E. satyrus, Westwood, Gen. Diurn. Lep. p. 461, n. 1, note, t. 72, f. 11 (1851).
Bartica; Quonga; Takutu; Carimang River; Kaieteur Falls.

292. CREMNA ACTORIS.
Papilio actoris, Cramer, Pap. Ex. I, t. 93 D (1779).
Quonga; Carimang River; Mt. Roraima.

293. NAPAEA EUCHARILA.
Cremna eucharila, Bates, Trans. Ent. Soc. 1867, p. 543 (1867).
Demerara; Carimang River.

294. NAPAEA BELTIANA.
N. beltiana, Godman, Trans. Ent. Soc. 1903, p. 541.
Demerara.

295. NAPAEA ORPHEUS.
Cremna orpheus, Doubleday & Hewitson, Gen. Diurn. Lep. t. 71, f. 8 (1851).
Berbice.

296. NAPEA SYLVA.
Charis sylva, Moschler, Verh. Zool.—Bot. Ges. Wien. XXVI, p. 304, t, 3, f. 6 (1876).
Potaro River (Coll. Kaye).

297. ALESA AMESIS.
Papilio amesis. Cramer, Pap. Ex. II, t. 104, F (1779).
Demerara; Carimang River; Quonga. Sometimes common.

298. MIMOCASTNIA ROTHSCHILDI.
M. rothschildi, Seitz, Macrolep. V, p. 652, t. 127, A (1916).
This fine species is only known from the Demerara River where it is extremely rare.

299. THEMONE PAIS.
Helicopis pais Hubner. Samml. Ex. Schmett. (1816—41).
Annai; Mt. Roraima; Nappi; Kanuku Mts. (J. G. Myers, 18/12/35).

300. ITHOMIOLA FLORALIS.
I. floralis, Felder, Reise Nov. Lep. II, p. 311, n. 422 (1865).
Carimang River; Kaieteur Falls.

301. PHELES HELICONIDES.
P. heliconides, Herrich-Schaeffer, Ex. Schmett. p. 277, f. 30 (1853?).
Carimang River.

302. ISAPIS AGYRTUS.
Papilio agyrtus, Cramer, Pap. Ex. II, t. 123, B, C (1779).
Demerara River; Annai; Carimang River.

303. PANARA PHERECLUS.
Papilio phereclus, Linnaeus, Syst. Nat. I, p. 484, n. 159 (1758).
Quonga; Annai; Mt. Roraima.

304. RIODINA LYSIPPUS.
Papilio lysippus, Linnaeus, Syst. Nat. I, p. 485, n. 160 (1758).
Annai; Takutu; Kaieteur Falls; Mt. Roraima. A rather common species.

305. LYMNAS MELANDER.
Papilio melander, Cramer, Pap. Ex. IV, t. 336, A. B (1782).
Carimang River.

306. LYMNAS JARBAS.
Papilio jarbas, Fabricius, Mant. Ins. II, p. 83, n. 749 (1787).
Quonga.

307. LYMNAS UBIA.
L. ubia, Felder, Reise Nov. Lep. II, p. 303, n. 408 (1865).
Annai. The British Museum also contains two specimens from Quonga in which the band is white and the red spots are absent above. It is uncertain whether this is a variety or a different species.

308. LYMNAS THYATIRA.
L. thyatira, Hewitson, Ex. Butt. I, Limnas t. 1, f. 6 (1852).
Quonga.

309. SYRMATIA DORILAS.
Papilio dorilas, Cramer, Pap. Ex. I, t. 47, C (1779).
Annai.

310. ZEONIA FAUNUS.
Papilio faunus, Fabricius, Syst. Ent. p. 532, n. 380 (1775).
Potaro River (Coll. Kaye).

311. ZEONIA BATESII.
Z. batesii, Saunders, Trans. Ent. Soc. 1859, p. 97, t. 10, f. 3, 4 (1859).
A pair from Annai in the British Museum.

312. DIORHINA ARCIUS.
Papilio arcius, Johansen, Amoen. Acad. VI, p. 409, n. 79 (1764).
Kaieteur Falls. I took one specimen at sugar, the only instance in my experience of a member of this family coming to the bait.

313. DIORHINA PERIANDER.
Papilio periander, Cramer, Pap. Ex. II, t. 188, C (1779).
Annai; Carimang River; Mt. Roraima.

314. ANCYLURUS AULESTES.
Papilio aulestes, Cramer, Pap. Ex. II, t. 128, G (1779).
Annai; Bartica; Carimang River; Kaieteur Falls; Mt. Roraima. Both sexes are very variable and the varieties have received a number of names.

315. ANCYLURUS TEDEA.
Papilio tedea, Cramer, Pap. Ex. II, t. 102, A (1779).
Demerara; Quonga.

316. CYRENIA MARTIA.
C. martia, Westwood, Gen. Diurn. Lep. p. 434, t. 72, f. 2 (1851).
Quonga.

317. NOTHEME EUMEUS.
Papilio eumeus, Fabricius, Spec. Ins. II, p. 63, n. 280 (1781).
Omai.

318. ESTHEMOPSIS AEOLIA.
E. aeolia, Bates, Journ. Linn. Soc. IX, p. 380 (1868).
Quonga.

319. ESTHEMOPSIS SERICINA.
Pseudopheles sericina, Bates, Trans. Ent. Soc. 1867, p. 544.
Potaro River (Coll. Kaye).

320. MESENE PHAREUS.
Papilio phareus, Cramer, Pap. Ex. II, t. 170, C (1779).
Bartica; Annai; Quonga; Carimang River; Upper Corentyne. A very variable species. The larva, according to Kaye, lives upon *Paullina pinnata*.

321. MESENE BOMILCAR.
Papilio bomilcar, Stoll, Suppl. Cram. t. 39, f. 3 (1790).
Bartica.

322. MESENE EPAPHUS.
Papilio epaphus, Cramer, Pap. Ex. IV, t. 335, D, E (1782).
Annai.

323. MESENE NOLA.
M. nola, Herrich-Schaeffer, Ex. Schmett. f. 23, (1852?).
Annai; Quonga.

324. MESENE PYRRHA.
M. pyrrha, Bates, Journ. Linn. Soc. Zool. IX, p. 389 (1868).
Annai. The last three are very likely all forms of one species.

325. PHAENOCHITONIA CINGULUS.
Papilio cingulus, Stoll, Suppl. Cram. t. 13, f. 4, 4D (1790).
Carimang River.

326. PHAENOCHITONIA AEROPE.
Poeotis aerope, Doubleday & Hewitson, Gen. Diurn. Lep. t. 71, f. 2 (1851).
Annai.

327. PHAENOCHITONIA PYRSODES.
Mesene pyrsodes, Bates, Journ. Linn. Soc. Zool. IX, p. 386 (1868).
Kamakusa.

328. PHAENOCHITONIA SAGARIS.
Papilio sagaris, Cramer, Pap. Ex. I, t. 83, D (1779).
Potaro River; Mt. Roraima.

329. CRICOSOMA IRRORATA.
C. irrorata, Godman, Trans. Ent. Soc. 1903, p. 540, t. 22, f. 6.
Carimang River; Kaieteur Falls.

330. CRICOSOMA HIPPEA.
Symmachia hippea, Herrich-Schaeffer, Ex. Schmett. f. 39, 40 (1853?).
Demerara River; Carimang River; Potaro Road; Kaieteur Falls.

331. PACHYTHONE LATERITIA.
P. lateritia, Bates, Journ. Linn. Soc. Zool. IX, p. 390 (1868).
Annai.

332. SYMMACHIA AMAZONICA.
S. amazonica, Bates, Journ. Linn. Soc. Zool. IX, p. 193 (1868).
Quonga.

333. ARGYROGRAMMA VENILIA.
Chartis venilia, Bates, Journ. Linn. Soc. Zool. IX, p. 393 (1868).
Mt. Roraima.

334. ARGYROGRAMMA TROCHILA.
Baeotis trochila, Westwood, Gen. Diurn. Lep. p. 451, n. 10. note (1851).
Carimang River.

335. ANTEROS FORMOSUS.
Papilio formosus, Cramer, Pap. Ex. II, t. 118, G (1779).
Annai.

336. ANTEROS VIOLETTA.
A. violetta, spec. nov.

Description.—Size and shape much as in *A. formosus* but hind wings more dentate and having a tuft of long hairs at the anal angle. Upperside of both wings blackish brown with a faint bluish tinge; fore wings with a large translucent white spot placed transversely in cellule 2. Underside: Fore wings marked much as in *Sarota gyas* but the large white discal spot is present as above, the inner of the two metallic blue-green submarginal stripes of *gyas* is absent and there is a triangular white spot below the base of costa. Hind wings also marked much as in *Sarota gyas* but the actual base is white and the black dots in the central area are arranged in three irregular series, the middle ones dusted with metallic scales; two metallic blue-green submarginal lines and a broad yellow marginal stripe as in *S. gyas*. Legs densely hairy.

Type from King Frederick William Falls, Upper Corentyne. (G. A. Hudson, March 1936. This is a rather remarkable species resembling *A. formosus* above and *Sarota gyas* beneath. A second specimen with an illegible locality label is also in the British Museum.

337. SAROTA CHRYSUS.
Papilio chrysus, Cramer, Pap. Ex. IV, t. 380, D, E. (1782).
Carimang River.

338. SAROTA GYAS.
Papilio gyas, Cramer, Pap. Ex. I, t. 28, F, G (1775).
Kaieteur Falls, Kuturi Sources. One of the smallest of all South American butterflies.

339. SAROTA ACANTHOIDES.
Nymphidium acanthoides, Herrich-Schaeffer, Ex. Schmett. f. 49, 50 (1853?).
Carimang River.

340. OUROCNEMIS AXIOCHUS.
Anteros axiochus, Hewitson, Ex. Butt. IV, *Anteros* t. 1, f. 1, 2 (1867)
King Frederick William Falls, Upper Corentyne River (G. A. Hudson).

341. CHARIS ANIUS.
Papilio anius, Cramer, Pap. Ex. I, t. 92, B (1779).
Quonga; Bartica; Carimang River; Kaieteur Falls; Mt. Roraima. A common species.

342. CHARIS CLEONUS.
Papilio cleonus, Cramer, Pap. Ex. IV, t. 380, H, I (1782).
Demerara; Carimang River; Kaieteur Falls; Mt. Roraima. Also rather common.

343. CHARIS ZAMA.
C. zama, Bates, Journ. Linn. Soc. Zool. IX, p. 392 (1868).
Annai.

344. CHARIS ARGYRODINES.
C. argyrodines, Bates, Ent. Mo. Mag. III, p. 154, n. 112 (1866).
A very common species in all wooded places.

345. AMARYNTHIS MENERIA.
Papilio meneria, Cramer, Pap. Ex. I, t. 94, D, E (1779).
Potaro River; Mabaruma.

346. EMESIS LUCINDA.
Papilio lucinda, Cramer, Pap. Ex. I, t. 1, E, F. (1775).
Parika; Carimang River; Takutu.

347. EMESIS MANDANA.
Papilio mandana, Cramer, Pap. Ex. III, t. 271, E, F. (1782).
Quonga; Demerara River; Mabali.

348. EMESIS OVIDIUS.
Hesperia ovidius, Fabricius, Ent. Syst. III, (1), p. 320, n. 212 (1793).
Demerara (G. Rodway).

349. EMESIS PROGNE.
E. progne, Godman, Trans. Ent. Soc, 1903, p. 537, t. 21, f. 10.
Potaro River (Coll. W. J. Kaye).

350. PARNES PHILOTES.
P. philotes, Westwood, Gen. Diurn. Lep. p. 464 (1851).
Annai; Quonga; Carimang River; Mt. Roraima.

351. HAMEARIS EPULUS.

Papilio epulus, Cramer, Pap. Ex. I, t. 50, C, D (1779).

Bartica; Demerara. Unlike most members of the family the species of this genus frequent open weedy places, fly close to the ground and settle with the wings closed.

352. METACHARIS LUCIUS.

Hesperia lucius, Fabricius, Ent. Syst. III, (1), p. 319, n. 209 (1793)

Demerara River; Annai; Carimang River; Mabaruma.

353. LEMONIAS RHODOPE.

L. rhodope, Hewitson, Ex. Butt. I, *Lemonias*, t. 1, f. 6, 7 (1853).

Potaro River.

345. LEMONIAS ZEANGER.

Papilio zeanger, Stoll, Suppl. Cram. t. 37, f. 2, 2b (1790).

Annai.

355. LEMONIAS PORTHAON.

Papilio porthaon, Dalman, Anal. Ent. p. 46 (1823).

Carimang River.

356. LEMONIAS FANNIA.

L. fannia, Godman, Trans. Ent. Soc. 1903, p. 545, t. 23, f. 4.

Annai. Only the type specimen known.

357. LEMONIAS CEREALIS.

L. cerealis, Hewitson, Ex. Butt. III, *Lemonias*, t. 4, f. 37 (1863).

Carimang River.

358. LEMONIAS NOMIA.

L. nomia, Godman, Trans. Ent. Soc. 1903, p. 544.

Annai.

359. LEMONIAS EMYLIUS.

Papilio emylius, Cramer, Pap. Ex. I, t. 66, G, H (1779).

The commonest species of the genus. Generally to be found in all forests and wooded places.

360. LEMONIAS LUCIANUS.

Hesperia lucianus, Fabricius, Ent. Syst. III, (1), p. 313, n. 185 (1793).

Annai; Quonga.

361. LEMONIAS LYNCESTES.

L. lyncestes, Hewitson, Ex. Butt. V. *Lemonias*, f. 50, 51 (1874).

Kaieteur Falls (A. Hall).

362. ECHENAIS TINEA.

Calydna tinea, Bates, Journ. Linn. Soc Zool, IX, p. 394 (1868).

Kaieteur Falls.

363. ECHENAIS ARISTUS.
Papilio aristus, Stoll, Suppl. Cram. t. 39, f. 4, 4C (1787).
Bartica; Kaieteur Falls; Mabaruma. Rather common.

364. ECHENAIS HÜBNERI.
Lemonias hübneri, Butler, Journ. Linn. Soc. Zool. IX, p. 214, t. 6, f. 4, 5 (1867).
Bartica; Carimang River.

365. ECHENAIS LEUCOCYANA.
E. leucocyana, Hübner, Zutr. Ex. Schmett. f. 915, 916 (1837).
Annai.

366. ECHENAIS PENTHEA.
Papilio penthea, Cramer, Pap. Ex. II, t. 143, E (1779).
Bartica; Carimang River; Kaieteur Falls; Mabaruma. A fairly common species.

367. ECHENAIS ANNULIFERA.
Lemonias annulifera, Godman, Trans. Ent. Soc. 1903, p. 542, t. 22, f. 12.
Described from Quonga and only found elsewhere on the Rio Madeira.

368. ECHENAIS AEMULIUS.
Hesperia aemulius, Fabricius, Ent. Syst. III, (1), p. 322, n. 219, (1793).
Mt. Roraima.

369. ECHENAIS ZERUA.
Lemonias zerua, Hewitson, Ex. Butt. V, *Lemonias*, t. 5, f. 44, 45 (1872)
Mt. Roraima.

370. NYMPHIDIUM TYTIA.
Papilio tytia, Cramer, Pap. Ex. II, t. 121, C, D (1779).
Demerara River (G. Rodway).

371. NYMPHIDIUM ORESTES.
Papilio orestes, Cramer, Pap. Ex. III, t. 282, A, B (1782).
Nymphidium arche, Hewitson, Ex. Butt. III, *Nymphidium* t, 2, f. 10 (1865).
Demerara River; Potaro River; Carimang River; Mabaruma. According to Stichel this species is dimorphic, the females of *orestes* having the bands yellow whilst in *arche* they are white. Both forms are found together.

372. NYMPHIDIUM ABARIS.
Papilio abaris, Cramer, Pap. Ex. I, t. 93, C (1779).
Demerara; Potaro River; Carimang River; Takutu.

373. NYMPHIDIUM GELA.
N. gela, Hewitson, Ex. Butt. I, *Nymphidium*, t. 1, f. 9 (1852).
Carimang River.

374. NYMPHIDIUM PHYLLEUS.
Papilio phylleus, Cramer, Pap. Ex. I, t. 63, D, E (1779).
Demerara (G. Rodway).

375. NYMPHIDIUM PELOPS.
Papilio pelops, Cramer, Pap. Ex. II, t. 170, F (1779).
Demerara River.

376. NYMPHIDIUM REGULUS.
Hesperia regulus, Fabricius, Ent. Syst. III, (1), p. 318, n. 205 (1795).
Annai.

377. NYMPHIDIUM LAMIS.
Papilio lamis, Cramer, Pap. Ex. IV, t. 335, F, G (1782).
Annai; Quonga; Carimang River.

378. NYMPHIDIUM SATYROIDES.
Nymula satyroides, Lathy, Ann. Mag. Nat. Hist. (10), IX, p. 73 (1932).
Type from "British Guiana" (Parish) in the British Museum.

379. NYMPHIDIUM MOLPE.
Limnas subtilis molpe, Hübner, Samml. Ex. Schmett. (1806-16).
Parika.

380. NYMPHIDIUM AZANOIDES.
N. azanoides, Butler, Ent. Mo. Mag. III, p. 221 (1867).
Annai; Carimang River; Kaieteur Falls.

381. NYMPHIDIUM FULMINANS.
N. fulminans, Bates, Journ. Linn. Soc. Zool. IX, p. 400 (1868).

382. NYMPHIDIUM LISIMON.
Papilio lisimon, Stoll, Suppl. Cram. t. 39, f. 1, 1a (1790).
Bartica; Mabaruma; Kaieteur Falls, etc. A very common species.

383. NYMPHIDIUM BAEOTIA.
N. baeotia, Hewitson, Ex.-Butt. I, *Nymphidium*, t. 1, f. 5 (1852).
Demerara; Annai; Carimang River; Mabaruma; Parika; Kaieteur Falls. Abundant in many places.

384. NYMPHIDIUM MANTUS.
Papilio mantus, Cramer, Pap. Ex. I, t. 47, F, G (1779).
Annai; Quonga; Carimang River.

385. NYMPHIDIUM CARICAE.
Papilio caricae, Linnaeus, Syst. Nat. I, p. 484, n. 158 (1758).
Generally common in all forest districts.

386. NYMPHIDIUM ACHEROIS.
Desmozona acherois, Boisduval, Spec. Gen. I, t. 21, f. 1 (1836).
Bartica; Annai; Carimang River; Takutu; Kaieteur Falls.

387. NYMPHIDIUM CACHRUS.

Papilio cachrus, Fabricius, Mant. Ins. II, p. 78, n. 715 (1787).

Generally distributed and very common.

388. NYMPHIDIUM MENALCUS.

Papilio menalcus, Cramer, Pap. Ex. IV, t. 290, K (1782).

Mabaruma; Kaieteur Falls. Perhaps only a form of *N. cachrus*, in which case the name has priority.

389. NYMPHIDIUM CALYCE.

N. calyce, Felder, Wien. Ent. Mon. VI, p. 72, n. 41 (1862).

Potaro River. Probably also elsewhere as it is a very common species in most parts of its extensive range.

390. BAEOTIS HISBON.

Papilio hisbon, Cramer, Pap. Ex. I, t. 83, C (1779).

Demerara (G. Rodway).

391. THISBE IRENAEA.

Papilio irenaea, Cramer, Pap. Ex. IV, t. 328, C, D (1782).

Annai; Quonga; Mt. Roraima. Unlike most of this group, this species always settles with the wings closed.

392. ANATOLE ZYGIA.

Lemonias maculata zygia, Hubner, Samml. Ex. Schmett. (1806-16).

Quonga; Upper Corentyne.

393. THAROPS HEBRUS.

Papilio hebrus, Cramer, Pap. Ex. I, t. 50, E, F (1779).

Potaro River.

394. THAROPS MENANDER.

Papilio menander, Cramer, Pap. Ex. IV, t. 334, C, D (1782).

Demerara River; Potaro River.

395. DYSMATHIA PORTIA.

D. portia, Bates, Journ. Linn. Soc. Zool. IX, p. 383 (1868).

In the British Museum from "British Guiana."

396. PANDEMOS PASIPHAË.

Papilio pasiphaë, Cramer, Pap. Ex. I, t. 80, E (1779).

Demerara (Rodway); Annai; Carimang River; Potaro River. One of the largest species of the family and always rare.

397. STALACHTIS EUTERPE.

Papilio euterpe, Linnaeus, Syst. Nat. I, p. 466, n. 49 (1758).

Annai; Kamakusa; Kuturi River.

398. STALACHTIS CALLIOPE.

Papilio calliope, Linnaeus, Syst. Nat. I, p. 466, n. 46 (1758).

Annai; Kuturi River. Apparently common at Annai.

399. STALACHTIS PHAEDUSA.
S. phaedusa, Hübner, Zutr. Ex. Schmett. f. 13, 14 (1818).
Potaro Road; Kuturi River.

400. STALACHTIS DUVALII.
Heliconius duvalii, Perty, Del. Anim. Art. p. 153, t. 30, f. 1, 1b (1830-34).
In the British Museum from British Guiana.

401. STALACHTIS ZEPHYRITIS.
Papilio zephyritis, Dalman, Anal. Ent. p. 47 (1823).
Bartica; Carimang River; Kamakusa.

402. ARICORIS LAGUS.
Papilio lagus, Cramer, Pap. Ex. II, t. 117, F, G (1779).
Demerara; Bartica; Quonga; Carimang River; Mt. Roraima.

403. ARICORIS SALVINI.
A. salvini, Staudinger, Ex. Tagf. I, p. 264, t. 93 (1888).
Mt. Roraima.

404. THEOPE EUDOCIA.
T. eudocia, Westwood, Gen. Diurn. Lep. p. 439, t. 70, f. 4 (1851).

Annai; Quonga; Carimang River. Some very interesting notes on the association of the larvae of this species with ants are given by P. L. Guppy in Kaye's "Catalogue of the Butterflies of Trinidad".

405. THEOPE HYPOXANTHA.
T. hypoxantha, Bates, Journ. Linn. Soc. Zool. IX, p. 405 (1868).
Carimang River.

406. THEOPE FOLIORUM.
T. foliorum, Bates, Journ. Linn. Soc. Zool, IX, p. 407 (1868).
Potaro River (Kaye).

407. THEOPE LYCAENINA.
T. lycaenina, Bates, Journ. Linn. Soc. Zool. IX, p. 406 (1868).
Annai; Carimang River.

408. THEOPE COMOSA.
T. comosa, Stichel, Gen. Ins. 112, p. 356.
Tumatumari (W. J. Kaye).

409. THEOPE SERICEA.
T. sericea, Bates Journ. Linn. Soc. Zool. IX, p. 404 (1868).

Annai; Carimang River.

410. THEOPE THESTIAS.
T. thestias, Hewitson, Ex. Butt. II, Theope, t. 1, f. 5, 6 (1860).
Potaro River (C. B. Roberts).

Family LYCAENIDAE.

411. **Hemiargus hanno.**

Papilio hanno, Stoll, Suppl. Cram. Pap. Ex. t. 39, f. 2 (1790).

Generally distributed and common, frequenting dry grassy places near cultivation.

412. **Leptotes cassius.**

Papilio cassius, Cramer, Pap. Ex. I, t. 23, C, D (1775).

Carimang River; Mabaruma; Mt. Roraima. A common and probably generally distributed species.

413. **Theclopsis eryx.**

Papilio eryx, Cramer, Pap. Ex. II, t. 143, D (1779).

Mabaruma (A. Hall).

Genus THECLA F.

This extensive genus is here treated in its broadest sense as is done in Seitz's "American Rhopalocera"; the attempts of various authors to divide it up into a number of genera have not met with general acceptance.

414. **Thecla imperialis.**

Papilio regalis, Cramer, Pap. Ex. I, t. 76, E, F (1779).

Mabaruma.

415. **Thecla regalis.**

Papilio regalis, Cramer, Pap. Ex. I, t. 72, E, F (1779).

I found a wing of this fine species in a spider's web at the Kaieteur Falls

416. **Thecla ganymedes.**

Papilio ganimedes, Cramer, Pap. Ex. I, t. 40, C, D (1776).

Potaro River.

417. **Thecla batesii.**

T. batesii, Hewitson, Ill. Diurn. Lep. p. 72, t. 27, f. 6. (1865).

Carimang River.

418. **Thecla ornatrix.**

T. ornatrix, Druce, Proc. Zool. Soc. 1907, p. 570, t. 31, f. 5.

Described from the Demerara River.

419. **Thecla nobilis.**

T. nobilis, Herrich-Schaeffer, Ex. Schmett. f. 55, 56 (1853).

Potaro River (W. J. Kaye, May 1901).

420. **Thecla telemus.**

Papilio telemus, Cramer, Pap. Ex. I, t. 4, D, E (1775).

Carimang River; Mt. Roraima.

421. THECLA VENULIUS.
Papilio venulius, Cramer, Pap. Ex. III, t. 243, G (1782).
Annai.

422. THECLA SATYROIDES.
T. satyroides, Hewitson, Ill. Diurn. Lep. p. 74, t. 29, f. 10, 12, 13 (1865).
Annai.

423. THECLA MARSYAS.
Papilio marsyas, Linnaeus, Syst. Nat. I, p. 482, n. 149 (1758).
Generally distributed but never abundant. In the Botanical Gardens at Georgetown (A. Hall).

424. THECLA LISUS.
Papilio lisus, Stoll, Suppl. Cram. t. 38, f. 2, 2b (1790).
Carimang River.

425. THECLA VIRESCO.
T. viresco, Druce, Proc. Zool. Soc. 1907, p. 572.
Described from British Guiana.

426. THECLA HEMON.
Papilio hemon, Cramer, Pap. Ex. I, t. 2, D, E (1775).
Bartica; Mabaruma; Carimang River. Fairly common.

427. THECLA MAVORS.
Theritas mavors, Hübner, Zutr. Ex. Schmett. f. 189, 190 (1818).
Bartica; Carimang River; Mt. Roraima.

428. THECLA DIDYMAON.
Papilio didymaon, Cramer, Pap. Ex. II, t. 134, A (1779).
Quonga; Carimang River; Mt. Roraima.

429. THECLA PHALEROS.
Papilio phaleros, Linnaeus, Syst. Nat. I, (2), p. 796 (1767).
Parika; Rockstone.

430. THECLA NUMEN.
T. numen, Druce, Proc. Zool. Soc. 1907, p. 574, t. 32, f. 4, 5.
Decribed from Mt. Roraima. A very distinct species.

431. THECLA LINUS.
Papilio linus, Sulzer, Gesch. Ins. t. 19, f. 10, 11 (1776).
Perhaps the commonest species of the genus. Abundant in all swampy places. Larva on *Solanum*.

432. THECLA DOLYLAS.
Papilio dolylas, Cramer, Pap. Ex. II, t. 111, B, C (1779).
Quonga; Carimang River; Mabaruma.

433. THECLA PALEGON.
Papilio palegon, Cramer, Pap. Ex. III, t. 282, C, D (1782).
Demerara River.

434. THECLA TEMESA.
T. temesa, Hewitson, Desc. Lyc. p. 1, n. 2 (1868).
Annai; Kaieteur Falls.

435. THECLA COLOR.
T. color, Druce, Proc. Zool. Soc. 1907, p. 581, t. 33, f. 11.
Deecribed from British Guiana. Also in the British Museum from Annai.

436. THECLA SISTA.
T. sista, Hewitson. Ill. Diurn. Lep. p. 91, t. 37, f. 98, 99 (1867).
Carimang River; Mt. Roraima.

437. THECLA ERGINA.
T. ergina, Hewitson, Ill. Diurn. Lep. p. 105, t. 43, f. 170, 171 (1867).
Kaieteur Falls.

438. THECLA PUNCTUM.
T. punctum, Herrich-Schaeffer, Ex. Schmett. f. 57, 58 (1853).
Annai, Chalk Hill, Essequibo (Coll. Ent. Div.).

439. THECLA MUNDITIA.
T. munditia, Druce, Proc. Zool. Soc. 1907, p. 586, t. 34, f. 10, 11.
Types from Bartica.

440. THECLA COLUMBICOLA.
T. columbicola, Strand, Lep. Niep. (1), p. 16, t. 14, f. 27, 28 (1916).
Mabaruma (A. Hall).

441. THECLA INGAE.
Papilio ingae, Sepp, Surin. Vlind. I, t. 17, (1848).
Quonga; Mabaruma.

442. THECLA CAUTER.
T. cauter, Druce, Proc. Zool. Soc. 1907, p. 589, t. 34, f. 15.
Described from "British Guiana".

443. THECLA NIVEPUNCTATA.
T. nivepunctata, Druce, Proc. Zool. Soc. 1907, p. 592, t. 35, f. 1.
Also described from "British Guiana".

444. THECLA SYNCELLUS.
Papilio syncellus, Cramer, Pap. Ex. IV. t. 334, A, B (1782).
Carimang River.

445. THECLA PELION.
Papilio pelion, Cramer, Pap. Ex. I, t, 6, E, F (1775).
Demerara River; Annai; Rockstone and Berbice.

446. THECLA STREPHON.
Papilio strephon, Fabricius, Syst. Ent. p. 522, n. 334 (1775).
Annai; Mt. Roraima.

447. THECLA CYLLARUS.
Papilio cyllarus, Cramer, Pap. Ex. I, t. 27, C, D (1775).
Parika; Annai; Carimang River; Kaieteur Falls; Mabaruma.

448. THECLA SYEDRA.
T. syedra, Hewitson, Ill. Diurn. Lep. p. 108, t. 39, f. 128, 129; t. 41, f. 145 (1867).
Annai.

449. THECLA FALERINA.
T. falerina, Hewitson, Ill. Diurn. Lep. p. 96, t. 43, f. 168, 169 (1867).
Annai.

450. THECLA PHOLEUS.
Papilio pholeus, Cramer, Pap. Ex. II, t. 163, D, E (1779).
Carimang River; Oronoque-New River confluence.

451. THECLA ECHION.
Papilio echion, Linnaeus, Syst. Nat. I, (2), p. 788, n. 224 (1767).
In the Botanical Gardens, Georgetown. Probably to be found elsewhere in the vicinity of orange trees.

452. THECLA CROLUS.
Papilio crolus, Cramer, Pap. Ex. IV, t. 333, G, H (1782).
Annai; Carimang River.

453. THECLA EREMA.
T. erema, Hewitson, Ill. Diurn. Lep. p. 104, t. 44, f. 179, 180 (1867).
Annai.

454. THECLA PICUS.
T. picus, Druce, Proc. Zool. Soc. 1907, p. 606, t. 36, f. 9.
Described from British Guiana.

455. THECLA HESPERITIS.
Calycopis hesperitis, Butler & Druce, Cist. Ent. I, p. 107, (1872).
Annai; Mabaruma.

456. THECLA BEON.
Papilio beon, Cramer, Pap. Ex. IV, t. 319, B, C (1782).

Generally distributed and common. One of the smallest and most abundant species and rather variable.

457. THECLA ATRIUS.
T. atrius, Herrich-Schaeffer, Ex. Schmett. t. 14, f. 53, 54 (1853).
Annai; Quonga; Carimang River.

458. THECLA PUPPIUS.
T. puppius, Godman & Salvin, Biol. Cent.-Am. Rhop. II, p. 84 (1887).
Described from "British Guiana". In the British Museum from Carimang River, Annai and Mt. Roraima.

459. THECLA CERATA.
T. cerata, Hewitson, Ill. Diurn. Lep. p. 191, t. 76, f. 607, 608 (1877).
Mabaruma.

460. THECLA CAESARIES.
T. caesaries, Druce, Proc. Zool. Soc. 1907, p. 614, t. 36, f. 19.
Described from Bartica.

461. THECLA CELMUS.
Papilio celmus, Cramer, Pap. Ex. I, t. 55, G, H. (1779).
Parika; Bartica; Annai; Carimang River; Mt. Roraima. A common species.

462. THECLA CALCHINIA.
T. calchinia, Hewitson, Descr. Lyc. p. 21, n. 46 (1868).
Mt. Roraima.

463. THECLA DORYASA.
T. doryasa, Hewitson, Ill. Diurn. Lep. p. 180, t. 70, f. 527, 528 (1874).
Demerara.

464. THECLA SPURINA.
T. spurina, Hewitson, Ill. Diurn. Lep. p. 102, t. 39, f. 122, 123 (1867).
In the British Museum from Berbice.

465. THECLA BUPHONIA.
T. buphonia, Hewitson, Descr. Lyc. p. 25 (1868).
Carimang River.

466. THECLA TORQUEOR.
T. torqueor, Druce, Proc. Zool. Soc. 1907, p. 608.
Carimang River.

467. THECLA XENETA.
T. xyneta, Hewitson, Ill. Diurn. Lep. p. 193, t. 77, f. 611, 612 (1877).
Annai; Carimang River; Mt. Roraima.

468. THECLA FOYI.
T. foyi, Schaus, Proc. U.S. Nat. Mus. XXV, p. 417.
Omai.

469. THECLA ATHYMBRA.
T. athymbra, Hewitson, Ill. Diurn, Lep. p. 92, t. 36, f. 91, 92 (1867).
Quonga; Takutu.

470. THECLA MATHO.
T. matho, Godman & Salvin, Biol. Cent.-Am. II, p. 80 (1887).
Types from the Carimang River.

471. THECLA SIMAETHIS.
Papilio simaethis, Drurg, Ill. Ex. Ent. I, t. 1, f. 3 (1773).
Demerara River. A very widely distributed West Indian species but always found singly.

472. THECLA VOLUPIA.
T. volupia, Hewitson, Ill. Diurn. Lep. p. 177, t. 69, f. 517, 518 (1874).
Mabaruma.

Family PIERIDAE.

473. PIERIS MONUSTE.
Papilio monuste, Linnaeus, Mus. Ulr. p. 237 (1764).

The "Common White" of South America. Generally distributed and abundant, frequenting open or cultivated places.

474. PIERIS BUNIAE PHALOE.
P. phaloe, Godart, Enc. Meth. IX, p. 156 (1819).
Annai; Berbice (Coll. Ent. Div.).

475. ITABALLIA DEMOPHILE.
Papilio demophile, Linnaeus, Syst. Nat. I, (2), p. 761, n. 82 (1767).
Berbice.

476. PERRHYBRIS PYRRHA.
Papilio pyrrha, Fabricius, Syst. Ent. p. 464, n. 95 (1775).
Annai.

477. ARCHONIAS BELLONA.
Papilio bellona, Cramer, Pap. Ex. I, t. 13, E, F (1775).

There may be two races of this species in British Guiana. Specimen from Annai in the British Museum are typical but those from Mt. Roraima have the discal spots of the fore wings much shorter and the subapical spots absent. I have not seen sufficient specimens to say whether the difference is constant.

478. APPIAS DRUSILLA.
Papilio drusilla, Cramer, Pap. Ex. II, t. 207, C (1779).
Generally distributed and periodically common.

479. DAPTONOURA LYCIMNIA.
Papilio lycimnia, Cramer, Pap. Ex. II, t. 105, E, F (1779).
Potaro River; Carimang River; Mabaruma; Mt. Roraima.

480. HESPEROCHARIS NYMPHAEA.
H. nymphaea, Möschler, Verh. z. b. Wien XXVI, p. 296, t. 3, f. 1 (1876).
Tumatumari; Potaro River. A rare species.

481. LEUCIDIA BREPHOS.
Mancipium vorax brephos, Hübner, Samml. Ex. Schmett. (1806-16).

Bartica; Potaro Road; Mabaruma; Kaieteur Falls. This delicate little species has a very weak flight.

482. TERIAO LEUCE.
T. leuce, Boisduval, Spēc. Gēn. I, p. 659, n. 10 (1936).
Mabaruma.

483. TERIAS VENUSTA LIMBIA.

T. limbia, Felder, Wien Ent. Mon. V, p. 86, n. 47 (1861).

Generally distributed but less abundant than in some of the neighbouring countries.

484. TERIAS ALBULA.

Papilio albula, Cramer, Pap. Ex. I, t. 27, E (1775).

Common almost everywhere.

485. TERIAS AGAVE.

Papilio agave, Cramer, Pap. Ex. I, t. 20, H, I (1775).

A very local species. I found a colony of it near the Penal Settlement on the Mazaruni in February 1936. This is the only record I know of.

486. TERIAS ELATHEA.

Papilio elathea, Cramer, Pap. Ex. II, t. 99, C, D (1779).

Widely distributed but not very abundant.

487. TERIAS DAIRA LYDIA.

T. lydia, Felder, Wien Ent. Mon. V, p. 87, n. 50 (1861).

Quonga. Perhaps often overlooked owing to its close resemblance to *T. elathea.*

488. TERIAS GRATIOSA.

T. gratiosa, Doubleday Hewitson, Gen. Diurn. Lep. t. 9, f. 5 (1847).

I have only seen two old specimens in a French collection labelled "Guyane Anglaise," but as the species is common in Venezuela there is no reason to doubt the record.

489. CATOPSILIA EUBULE.

Papilio eubule, Linnaeus, Syst. Nat. I, (2), p. 764, n. 102 (1767).

One of the commonest butterflies everywhere but apparently not addicted to migrating or congregating in swarms like some of the other species of its genus.

490. CATOPSILIA PHILEA.

Papilio philea, Linnaeus, Syst. Nat. I, (2), p. 764, n. 104 (1767).

Widely distributed but not as a rule very abundant.

491. CATOPSILIA ARGANTE.

Papilio argante, Fabricius, Syst. Ent. p. 470, n. 116 (1775).

Generally distributed and often common.

492. CATOPSILIA TRITE.

Papilio trite, Linnaeus, Syst. Nat. I, p. 489, n. 70 (1758).

Generally distributed but as a rule the least abundant of the species found within our area.

493. CATOPSILIA STATIRA.

Papilio statira, Cramer, Pap. Ex. II, t. 120, C, D (1779).

Very abundant, especially at certain periods. Many records of the vast migratory swarms of this species have been published by C. B. Williams and others. Owing to its fondness for flying over water it is often to be seen in large numbers by travellers on the rivers.

494. GONEPTERYX MENIPPE.

Mancipium fidelis menippe, Hübner, Samml. Ex. Schmett. (1806-16).

Marudi Mtn., Rupununi District. (L. H. J. Ashburner).

495. DISMORPHIA LICINIA.

Papilio licinia, Cramer, Pap. Ex. II, t. 153, E, F (1779).

Takutu; Mabaruma.

496. DISMORPHIA CARTHESIS.

Leptalis carthesis, Hewitson, Trans. Ent. Soc. 1869, p. 71.

There are single males in the British Museum from Demerara (type) and Quonga but it is a very rare species everywhere.

497. DISMORPHIA AMPHIONE.

Papilio amphione, Cramer, Pap. Ex. III, t. 232, E, F (1782).

Demerara River; Berbice; Takutu. Rare.

498. DISMORPHIA CRISIA RORAIMAE.

D. crisia roraimae, subsp. nov.

Description. Male. All white markings reduced as compared with the darkest specimens of *D. crisia foedora* Lucas, faintly yellowish; the two parts of the band of fore wings well separated; in the anterior section the middle discocellular is broadly black so that the white spot in the cell is partly separated from the rest of the band.

Female. The light markings always yellowish, the spot in the cell of fore wings partly separated from the rest of the band as in the male.

Described from six males and four females from Mt. Roraima in the British Museum.

499. DISMORPHIA PROSERPINA.

D. proserpina, Grose Smith & Kirby, Rhop. Ex. II, p. 11, *Dismorphia*, t. 3, f. 1, 2, 3 (1897).

Described from Mt. Roraima and only known from there.

500. DISMORPHIA TAPAJONA.

Leptalis tapajona, Bates, Journ. Ent. I, p. 231, n. 3 (1861).

Carimang River; Cuyuni. I think this may prove to be the female of *D. laia*, Cramer, males of which are known from Surinam and French Guiana.

501. DISMORPHIA PINTHAEUS.

Papilio pinthaeus, Linnaeus, Mus. Ulr. p. 258 (1764).

Bartica; Carimang River; Kaieteur Falls; Mt. Roraima. Only found singly, generally in company with the species of *Aeria* and *Scada* which serve as its models.

Family PAPILIONIDAE.

502. Papilio triopas mithras.

P. mithras, Grose Smith, Rhop. Ex. III, *Papilio* t. 23 f. 1 (1902).

Demerara River; Bartica; Annai; Carimang River. Always a rare species.

503. Papilio aeneas.

P. aeneas, Linnaeus, Syst. Nat. I, p. 461, n. 15 (1758).

Demerara River; Bartica. Rather scarce. Camaria.

504. Papilio sesostris.

P. sesostris, Cramer, Pap. Ex. III, t. 211, F, G (1779).

Parika; Bartica; Annai; Quonga; Kaieteur Falls. This beautiful species is not rare in heavy forest.

505. Papilio phosphorus.

P. phosphorus, Bates, Trans. Ent. Soc. 1866, p. 342, note.

The type male came from Demerara and there are specimens in the Tring Museum from British Guiana but it is evidently a rare species.

506. Papilio vertumnus.

P. vertumnus, Cramer, Pap. Ex. III, t. 211, A, B (1782).

Demerara; Essequibo River; Camaria; Kaieteur Falls. A scarce and local species.

507. Papilio anchises.

P. anchises, Linnaeus, Syst. Nat. 460, n. 10 (1758).

Specimens from Quonga and "British Guiana" in the British Museum (two males) are intermediate between the typical form and the race *osyris* Felder from Venezuela.

508. Papilio panthonus.

P. panthonus, Cramer, Pap. Ex. III, t. 278, C, D (1782).

Demerara River; New Amsterdam; Bartica; Parika. Not very common where it is found.

509. Papilio lysander.

P. lysander, Cramer, Pap. Ex. I, t. 29, C, D (1775).

Bartica; Akyma; New Amsterdam; Berbice River; Mabaruma; Kaieteur Falls. One of the commoner species.

510. Papilio echemon ergeteles.

P. ergeteles, Gray, Cat. Lep. Ins. Brit. Mus. p. 52, t. 8, f. 5 (1852).

Annai; Camaria; Demerara River.

511. Papilio neophilus.

Priamides neopihlus, Hübner, Zutr. Ex. Schmett. F. 997, 998 (1837)

Bartica; Annai; Quonga. Not very common.

512. **Papilio arcas.**

P. arcas, Cramer, Pap. Ex. IV, t. 378, C (1782).

Recorded by Kaye from British Guiana. I have not seen a specimen but as it is a fairly common species in Venezuela on the one hand and Surinam on the other its existence in our Colony may be safely accepted.

513. Papilio polydamas.

P. polydamas, Linnaeus, Syst. Nat. I, p. 460, n. 11 (1858).

Generally distributed but less abundant than in most parts of South America.

514. Papilio belus.

P. belus, Cramer, Pap. Ex. II, t. 112, A, B (1779).

P. caburi, Kaye, "Entomologist" XXXIX, p. 51, t. 2, f. 1 (1906).

A female taken by W. J. Kaye on the old Caburi Road and forming the type of his *P. caburi* is the only British Guiana specimen I know of.

515. Papilio crassus.

P. crassus, Cramer, Pap. Ex. II, t. 112, C (1779).

In the British Museum from Berbice and in the Tring Museum from British Guiana.

516. Papilio thoas.

P. thoas, Linnaeus, Mant. Plant. p. 536 (1771).

Generally distributed and moderately common.

517. Papilio androgeus.

P. androgeus, Cramer, Pap. Ex. I, t. 16, C, D (1775).

Berbice; Bartica; Essequibo River. The female of this species is trimorphic but all the females I have seen from British Guiana are of the form *piranthus* Cramer (Pap. Ex. III, t. 204, A, B (1782).

518. Papilio hyppason.

P. hyppason, Cramer, Pap. Ex. I, t. 29, E (1775).

Demerara River; Berbice. A rare species.

519. Papilio anchisiades.

P. anchisiades, Esper, Ausl. Schmett. t. 13, f. 1, 2 (1788).

Georgetown; Berbice; Omai; Mabaruma. Sometimes a fairly common species. The larva feeds upon *Citrus* and is easy to rear.

520. Papilio torquatus.

P. torquatus, Cramer, Pap. Ex. II, t. 177, A, B (1779).

In the Georgetown Museum without locality and in the British Museum from "British Guiana."

METEOROLOGICAL DATA—APRIL TO JUNE, 1939.

Recording Stations & Months.	Rainfall.	NUMBER OF DAYS OF RAIN						Evaporation	Air Temperature and Humidity.			
	Total Inches.	Under .10 Inch	.10 to .50 Inch	.50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days.	Inches	Maximum.	Minimum.	Mean.	Humidity Mean
Botanic Gardens.												
April ...	8.80	5	7	3	1	1	17	4.78	83.7	76.0	79.8	81.0
May ...	7.25	6	9	3	2	...	20	5.09	84.5	76.4	80.4	80.8
June ...	7.53	7	16	3	1	...	27	4.33	84.8	76.1	80.4	83.8
Totals	23.58	18	32	9	4	1	64	14.20	...	...	...	...
Means	...	...	...	...	...	...	...	...	84.3	76.2	80.2	81.9
Berbice Gardens.												
April	18.21	3	7	5	1	2	18	...	83.7	73.5	78.6	85.8
May ...	5.02	8	12	3	...	...	23	...	86.1	72.4	79.2	80.1
June ...	11.10	6	16	2	4	...	28	...	86.2	74.9	80.5	82.6
Totals	34.33	17	35	10	5	2	69	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	85.3	73.6	79 4	82.8
Onderneeming.												
April ...	5.60	2	6	2	...	1	11	...	*	...	...	..
May ...	5.24	2	5	2	...	1	10	...	...	...	...	...
June ...	10.16	4	5	7	3	...	19	...	...	...	...	...
Totals	21.00	8	16	11	3	2	40	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	...	...	...	...
Hosororo, North West District												
April ...	6.65	4	15	2	2	...	23	...	86.0	71.2	78.6	83.4
May ...	6.91	3	7	4	2	...	16	...	88.6	71.2	79.9	81.8
June ...	12.52	3	15	7	1	1	27	...	85.2	71.8	78.5	88.4
Totals	26.08	10	37	13	5	1	66	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	86.6	71.4	79.0	84.5

* Records inaccurate.

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The
Agricultural Journal of British Guiana
December, 1939.

EDITORIAL.

FOOD PRODUCTION CAMPAIGN.

The previous number of this *Journal* appeared soon after war was declared. In that issue the desirability of growing more food was indicated in a general way; the situation was new and plans were not sufficiently advanced at that time to permit more specific treatment of the problem. The situation is still new but sufficient has now been done to indicate the lines along which the Colony is organizing itself to replace with its own products food supplies previously obtained from abroad.

A Food Production Committee with the Director of Agriculture as Chairman has been appointed to advise Government on the methods to be adopted in this campaign. Wheat flour is, in value, the most important single article of diet imported, and in view of the fact that supplies may become expensive and irregular, investigations were begun at once in connection with the substitution of some of the wheat flour used in bread by rice flour. The bakers interviewed did not at first react favourably to the idea; they had had previous experience only with rice flour which was not finely ground and which was unable to pass through anything finer than a 40-80 mesh screen; their objection was found to be due mainly to this fact. A first essential was therefore to produce in sample quantities rice flour approximating wheat flour in fineness. This the Department did. Several commercial bakeries helpfully co-operated in carrying out trials with bread containing 1 part of rice flour to 3 parts of wheat flour. Sample loaves thus obtained were distributed to 200 households and the comments received were, without exception, encouraging. At the stage now reached, investigations are being made locally and abroad in regard to suitable milling equipment and the cost of production in relation to wheat flour.

As local and Caribbean demands for rice are likely to become bigger, growers are being encouraged to increase plantings. In conjunction with this policy drainage and other agricultural conditions on the Government estates in Essequibo are to be improved for extended rice and ground provision cultivations by tenant growers. There are already signs that the coming spring crop will be much larger throughout the Colony than it was this year, while the estimated production of the 1939 autumn crop is the highest since 1935. It is hoped that weather conditions, which always play an important part, will be favourable.

In order to ensure orderly marketing and a satisfactory working arrangement for supplying the neighbouring West Indian Colonies, Government has instituted a comprehensive marketing scheme by which all the rice produced for sale will be controlled by a central organization.

Peas, beans and lentils form another group of commodities which enter largely into local consumption. Experience indicates that, among the pea and bean group, the black eye pea is the one likely to be most rapidly extended locally. District work has been undertaken to encourage the planting of a sufficient area in the coming rains to render the Colony independent of black eye pea imports, it being planned to grow two crops per year. Government is working out the details of a marketing scheme, the chief object of which is to ensure orderly release of peas on the market; only if alternating glut and scarcity are avoided can both grower and consumer reap the full benefit of a rapidly expanding local black eye pea industry; in this connection Government has provided a revolving fund of $8,000 for purchase and storage expenses connected with the scheme.

A feature of the "Grow More Food" activities is the work being done in the districts to help conserve planting material. Such material as it is thought that farmers will find it difficult to procure is being obtained by the Department. To ensure that planted areas will get a good start, not only seeds, but in deserving cases seedlings, will be distributed. Supervision of planting areas is being arranged for as far as practicable.

The production of more pickled meats is also being planned, the necessity for supporting the section of the Colony's population engaged in the gold and other industries in the interior being borne in mind. Certain West Indian markets, notably Trinidad, are likely to expect increased meat supplies from this country.

Allotment areas are being established near to Georgetown and New Amsterdam with the object of helping city dwellers to grow, at any rate in part, some of their food requirements.

In the efforts connected with the "Grow More Food" campaign active co-operation has been sought from, and assured by, the sugar estates. Advice to farmers has been published in simple language in the *Farm Journal*, reprints and leaflets distributed free of cost, and notes published periodically in the Press. Wherever desirable extension work is being done in consultation with the District Administration Staff and Village Authorities.

SUSPENSION OF PUBLICATION.

It has been decided that, as an economy measure, publication of the *Agricultural Journal of British Guiana* will be suspended for the duration of the war. This issue, which completes Volume X, will therefore be the last until the cessation of hostilities. The index for the Volume has been completed and is being distributed with this number.

ORIGINAL ARTICLES.

THE SOILS OF BRITISH GUIANA SOUTH OF THE 5TH PARALLEL, AND OF THE NORTH-WEST DISTRICT.*

BY

D. W. DUTHIE, PH.D., F.I.C.

Chemist, Department of Agriculture.

CONTENTS.

1. General.

The physical texture of the soil was considered to be the most important factor from the point of view of agricultural development by scientific methods, and all samples were subjected to mechanical analysis by Robinson's method. As the analytical data would be somewhat unwieldly in the main text, the tables of results have been placed in an Appendix, with a note on the analytical methods employed. Notes on the savannah pastures have also been included, and the available analyses have been collected in a table.

* A report on the area examined by the British Guiana Survey Commission functioning under the auspices of the President's Advisory Committee on Political Refugees. Published by permission of the Secretary of State for the Colonies and of the Secretary of the President's Advisory Committee on Political Refugees, New York.

The area has been divided into five sections :

(1) The rain forest area in the basin of the Essequibo River and its tributaries.

(2) The Rupununi Savannah country.

(3) The hilly forest country bordering the savannahs.

(4) The Berbice River and the Cattle Trail.

(5) The North-West District.

2. The Parent Rocks and Their Soils.

The age of the basement formation of British Guiana has not been definitely determined, but it is believed to be mainly Archaean. It consists of gneiss and metamorphosed sedimentary and volcanic rocks, intruded by granite and younger dykes of dolerite and other basic rocks. It is presumed that the Kaieteurean Sedimentary Series, which consists of sandstones, conglomerates, quartzites and shales, was laid down on this basement, possibly over most of the Colony. The age of this formation is not known; it has been compared with pre-Cambrian, Devonian, Permian, Triassic and Cretaceous formations of adjacent countries, without definite conclusions being possible. Extensive sills and dykes of gabbro and dolerite were subsequently intruded into the Kaieteurean, block-faulting it into its present form. Subsequent erosion has removed the Kaieteurean from most of the area, and it is now restricted to the outlying mass forming the Pakaraima Mountains.

Wide stretches of alluvial deposits—Pleistocene or Recent—now occupy the lower lands and river valleys. These were possibly derived from granites and other members of the basement formation, and they consist of water-worn sands of rather fine texture, interspersed with clays.

The basement rocks, gneiss and granite, outcrop frequently along the rivers, and from this it appears that they cover a large area of the country. The soil derived from them varies from a pinkish-red silty loam in the forest to a light yellow sand on the savannahs, the forest soils possessing some natural fertility while the leached savannah soil is definitely infertile. The basic intrusions produce a chocolate-coloured soil which has a high clay content, and has all the chemical and physical indications of a naturally fertile soil which would withstand continuous cultivation even under tropical conditions.

The Kaieteurean Series gives rise to sandy soils of low fertility, but the intrusive sills and dykes have formed restricted areas of more fertile soil, of which several were found by Follett-Smith on his tour in 1935 with the League of Nations Commission for settling Assyrians. The area south of 5°N occupied by elevated land of this formation is relatively small, and is confined to a corner of the Pakaraimas and a few isolated escarpment mountains.

The low-lying lands along the river banks do not give much promise of agricultural development. The widely meandering rivers have occupied many channels, and the light sandy alluvial deposits have been heavily leached by

periodic floodings. Areas of clay or loam would be much more amenable to agricultural improvement, but it is uncertain to what extent these occur. There is usually a distinct "river terrace" several miles from the present course of the river, and it is possible that there is an improvement in the soil at that point.

3. The Rain Forest Area of the Essequibo Basin.

Of approximately 40,000 square miles included in that part of British Guiana which lies south of 5°N., some 35,000 square miles are under forest, the basin of the Essequibo and its tributaries comprising the greater part of this. No soil investigations have previously been carried out in that area, and the scattered observations which were possible in the present survey are insufficient to permit confident generalisation. Only by using geology as a basis was it possible to gain any broad idea of the potential agricultural value of the area, but the geological information is also meagre, since detailed surveys have not been carried out.

With these limitations in mind, we can visualise this area as consisting partly of alluvial deposits and partly of granite with its basic intrusions. That the area is fundamentally granite is indicated by the very frequent outcrops of granite along all the river courses, but it is probable that the recent alluvial sands and clays have covered the basement rocks over large areas, particularly in river valleys.

The sandy alluvial soils are manifestly infertile, and this was amply demonstrated on an Indian farm at Rupununi Mouth, where even on newly cleared land only cassava was thriving. This soil type was sampled in profile in a grazing paddock at Apoteri and the analytical figures (Table I of Appendix, E484-489) show it to be an acid sand with nearly 80% coarse sand, low organic matter and nitrogen, and no available phosphate. The high clay content (37%) of the 30-36" sample suggests that most of the finer material had been washed into the subsoil, but it is doubtful if any cultural method could prevent this with the high rainfall of the district (86 ins. per annum at Kurupukari). The clays which geologists have included in this alluvial formation were not found, but they probably occur on some of the flat lands near the rivers, or as hill-wash.

Some of the sandhills are capped with concretionary ironstone, which seems to occupy only small areas. One of these hills, at Apoteri, was examined in some detail, and it was found that, on the hilltop the ironstone was over 3 feet thick, while halfway down the hill it gave way to sand about 6 inches from the surface. As a soil it appears to be agriculturally useless.

Thus the sandy areas along the rivers appear to be unsuitable for agricultural development, but there is the point that the accessible parts are old river beds, and the soil may be different on the "river-terraces," which, at Apoteri, are about 8 miles from the present river bed.

Red soil overlying the granite formation was sampled in profile at Massara, about 7 miles up the Essequibo River from Rupununi Mouth. It was

rather shallow and gravelly, but apart from this it gave indications of being a fertile soil. The coarse sand and clay fractions are approximately equal (30% each) and the analytical figures (Table I of Appendix, E479–483) show that it is only slightly acid; the organic matter and nitrogen are both high, and the figure for available phosphate is high for a tropical forest soil. This is the site of a Carib settlement which was abandoned over 30 years ago, and the gravelly nature of the soil may be partly due to erosion, although the ground is now covered with thick forest.

Approximately 2 miles downstream from Massara is an outcrop of a fine grained epidiorite which has intruded into the granite. The soil overlying this was also sampled, and proved to be heavier than that at Massara (44% clay as compared with 30%); it also shows up on analysis (Table I, E477 and 478) as a fertile soil.

It is possible that there may be some association between the soil overlying granite at Massara and the basic dyke which was found two miles downstream. For instance, the Massara sample may have been derived from the edge of the intrusion, and it is significant that the old geological maps of the Colony mark a basic dyke at Massara. This is an important point, as it is unlikely, in theory at least, that the gneissose granites of the basement formation could produce a fertile soil of good physical texture. In further work it is essential to determine the difference between soils derived from granite and those produced by weathering of the basic intrusive rocks.

A second deposit of moderately fertile red soil was found at an abandoned Boundary Commission camp at Oronoque Falls on the New River. The analytical data for a series of samples of this soil are given in Table I (E549–552). A similar type of soil was found in the Kanaku Mountains, on Marudi Mountain, and by Follett-Smith in the Yawong Valley in the Pakaraima Mountains, and these deposits are discussed in other sections of this report.

In his visit to the Rupununi valley in the Kanaku Mountains, Sir Geoffrey Evans found the fertile red soil to be associated with a palm, *Orbignya sagotii*, which might be a useful indicator plant. It was seen from the air during a reconnaissance flight up the Essequibo River (near Sawkins Island), and a landing was made in order to identify the palm and to sample its soil. The 0-6″ and 6-12″ samples did not conform to the idea that this palm is an indicator of fertile red soil, but an ants' nest nearby showed a bright red soil which had been brought up from over two feet below surface. The analysis of the top soil is given in Table I (E547 and 548) but samples of the red subsoil could not be obtained at the time, and the ants' nest material would not be a suitable sample.

4. THE RUPUNUNI SAVANNAH COUNTRY.

Investigations on the soils of the Rupununi savannahs have been carried out by Sir John Harrison and by Mr. R. R. Follett-Smith. Harrison had no opportunity of visiting these savannahs, but he reported on the examination of five soil samples from the Rupununi District (Combined Court paper

No. 744, 1914). These samples were collected by Mr. H. P. C. Melville, then Commissioner of the Rupununi District, and were taken from localities within a radius of three miles from Dadanawa. As the comparable analytical figures given by Harrison agree in the main with those of samples collected during the present survey, it will be sufficient to quote Harrison's conclusions :

> "The samples sent by the Commissioner, if, as he states they are, "truly representative of the districts, indicate that by far the greatest "portion of the area is a coarse sandy soil of low fertility, apparently at "present suited only to the production of coarse grasses for pastoral or "ranching purposes. Its very unfavourable physical condition does not "hold out any hopes of its ready amelioration by ordinary local cultural "methods. Where it is traversed by rivers and streams and their banks "are subject to flooding the soils are fertile and produce a "lush" grass "after such flooding. In places there are hollows or shallow depressions "in the savannahs where the soils are of considerable to high fertility, "capable of producing many varieties of tropical products; whilst the "savannahs are traversed by ridges or so-called "islands" of land the "soil of which from its physical nature is of well-marked fertility.
>
> "In connection with the sandy savannahs it must be remembered "that modern agricultural science has changed and greatly improved "certain methods of cultivation and introduced new methods, with the "result that "today is the day of the sandy soils." We therefore may "look forward to a time when the savannah soils of Berbice and of the "Rupununi may produce crops of kinds that at present I am unable to "indicate."

One statement in the main part of Harrison's report requiries comment. In reporting on a sample "taken from one of the low wave-like ridges that give these savannahs their rolling appearance. . . . . This sample is representative of about two-thirds of the savannah soil" he says :

> "As regards intensive cultivation the soil can only be classed in its "present state as sterile to barren. I know of no tropical product other "perhaps than Caera rubber that could be successfully raised on such "a soil in its natural condition.
>
> "The agricultural improvement of this soil would not be difficult. "It would require deep ploughing so as to bring up the finer particles "of the subsoil or even the earth underlying the subsoil so as to mix "with the somewhat coarse-textured surface-soil the finer-grained silt "and clay derived from the lower layers. Phosphoric acid should be "applied, preferably in the form of slag phosphates, in quantity from 6 "to 10 cwts. per acre. . . . . ."

His analytical figures do not bear out this suggestion in regard to improving the texture by deep ploughing, since his coarse sand (2–0.2 mm) figures for soil and subsoil (sampling depths are not recorded) are 73% and 67%, while the fine sand plus coarse silt (probably about 0.2-0.02 mm) percentages are respectively 27 and 25, clay being 4% and 7%. Large scale

cultivation of this soil would probably introduce serious erosion problems, owing to the high winds which prevail during the greater part of the year and the heavy rains during the wet season. On the other hand the cultivation of food crops by intensive methods is successfully practised by ranchers, who obtain good yields in corrals which have been heavily manured by cattle, horses, or sheep.

In their report on agricultural conditions in the Rupununi District (*Agr. Jl.* British Guiana, 1935, p. 155), Follett-Smith and Frampton give the analytical data for an example of the topsoil occurring on the elevated land of the northern savannahs. It is described as a markedly acidic light sand containing only small amounts of organic matter and exchangeable bases. The amount of readily available phosphate is low, and the value for the rate of solution suggests that the soil is not particularly fertile. A sample taken from a "bush island" in the southern savannah was also examined, and in this case the values for exchangeable bases and for the rate of solution suggested that this soil is more fertile than that of the open savannahs.

In order to test Harrison's view that the sandy savannah soils could be improved by deep ploughing, a profile pit was sampled in detail at Manari, in the northern savannah. The analytical results in Table II of the Appendix (E490–499) show that there is only a gradual change in texture with depth, and that there is no definite layer of fine earth underlying the subsoil. Ploughing to 2 feet would improve the texture slightly, but Harrison's words should not be taken too literally, even although the Manari soil is heavier in texture than the samples from Dadanawa which Harrison analysed. It is only at a depth of 3 ft. that the clay percentage exceeds that of coarse sand, and thus this soil will always be too light for extensive cultivation unless the severest anti-erosion methods are adopted. A feature of this profile was that the 3–12 inch horizon was dark in colour, baked, and compact, presumably on account of trampling by animals and of repeated savannah fires. Light ploughing or harrowing would undoubtedly increase the growth of grass, and might also improve the water relations of the soil, but its deficiency in plant foods would have to be corrected by liberal manuring before vegetable crops could be grown.

Two samples of top and subsoil were taken near Annai by Dr. Donovan and Colonel Nicholas on their journey down the cattle trail, and the analytical figures for these are also included in Table II (E516-519). One, taken at mile 179½, represents the general soil type of the district and is somewhat similar in texture to the Manari savannah soil; but the organic matter and nitrogen are higher, possibly because there is more standing water in this district during the wet season and therefore more opportunity for the accumulation of plant débris. The second sample, taken from flat land near the Government Rest House, is heavier in texture, and resembles a soil which was sampled near the creek at Manari and is discussed below.

One of Melville's samples was "a dark soil of considerable fertility, taken "from flat land extending about 100 yards on either side of a small creek

"draining the savannahs. This is covered with water during the rainy season." In his report Harrison says—

> "Both the mechanical and chemical analyses of the soil fully bear "out the Commissioner's opinion. The topsoil and subsoil are of very "favourable mechanical composition, the soil being a fairly light loam. "In the soil itself two of the important constituents of plant food, nitrogen and lime (calcium oxide), are present in satisfactory proportion, "whilst potash and phosphoric anhydride are somewhat low even for a "tropical residual soil. But the proportions of the mineral constituents "present in the subsoil indicate that with fairly deep cultivation the fertility of the land would tend to increase. The soil has the characteristics of a tropical fertile river or valley alluvial soil. If planted as "soon as possible after the termination of the rainy season this soil "should give heavy crops of maize, Guinea corn, hill rice, tobacco and "tropical garden crops generally."

While there are no extensive areas of this soil type, there are many small areas which agree with Melville's description, and it is interesting that Sir Crawford Douglas-Jones was struck by their resemblance to the "vlei" lands of Southern Rhodesia, which are cultivated in the manner suggested by Harrison. Two such areas were sampled, one in the southern savannah between Wariwau and Aishelton and one at Manari within a few yards of the sandy profile pit, and the analytical figures (Table II, E531, 532, 534–546) agree in general with Harrison's findings. In stock-farming these areas would be of inestimable value for fodder grasses as well as food crops, since Para Grass would undoubtedly flourish under these conditions.

The Chemical Composition of Savannah Pastures.

Samples of grasses from various parts of the Colony have been analysed in the Chemical Division and reported on by Follett-Smith. Except for those on the Government Stock Farm, Georgetown, where mineral mixtures are regularly fed to the stock, all the pastures show an extreme deficiency of phosphate, often accompanied by deficiencies in lime and potash. The figures have been collected in the accompanying table and are compared with those for a good natural British hill pasture, a poor Falkland Islands pasture, and a pasture from Molo, Kenya, where striking results were obtained by feeding mineral mixtures to the animals (Economic Advisory Council, 6th Report of Committee on the Mineral Content of Natural Pastures, 1931). From a search of the literature it appears that the limiting percentages of phosphorus in natural grazing is about 0.4, but it should be remembered that low grade stock can subsist on poorer pastures without showing visible effects.' Nevertheless, many of the cattle on the savannahs of this Colony have reached the bone-chewing stage, and it is unlikely that higher grade stock could keep healthy on such an area.

Mineral Content of Pasture Grasses.

(per cent. oven-dry weight)

	Silica-free ash	Phosphate	Lime	Potash
Grasses from the Interior of the Colony :				
1. *Trachypogon plumosus* (N. Rupununi)	1.0	0.03	0.14	0.40
2. *Trachypogon plumosus* (Waranama)	0.83	0.02	0.12	0.29
3. Savannah pasture (Shiriri Mts.)	2.4	0.15	0.24	0.50
4. Legume (*Desmodium?*) (Shiriri Mts.)	15.0	0.39	5.00	1.38
5. Kurasabi Savannah pasture	1.1	0.02	0.12	0.37
6. Paramakatoi pasture	1.7	0.05	0.09	0.61
7. Wynne Grass (N.W.D.)	3.87	0.26	0.48	—
8. Wynne Grass (Rupununi)	1.2	0.04	0.10	0.35
Other Grasses for comparison :				
9. British Hill pasture	5.85	0.67	0.65	2.66
10. Falkland Islands pasture	4.56	0.54	0.29	2.20
11. Molo Kenya	2.35	0.22	0.48	0.77
12. Mixed Pasture, Govt. Stock Farm, Georgetown	4.75	0.92	0.30	1.61

Wynne Grass from the North West District shows promise of being more nutritious, as regards minerals, than most of the Rupununi grasses, but it will be seen from the table that when this grass is planted in the Rupununi District it shows a very low mineral content. Thus it is unlikely that the introduction of better grasses would correct the mineral deficiencies of the savannah pastures. It appears that the soil does not contain the necessary components in an available form.

In 1924 Sir John Harrison discussed the subject in a critical memorandum (unpublished) on a report by Mr. J. Mullin (afterwards Commissioner of Lands and Mines). Mr. Mullin had stressed the deteriorating effect of excessive inbreeding in the Rupununi cattle, whereas Harrison says :

"A very remarkable feature of the savannah soils is their deficiency "in phosphoric acid. In my opinion it is hopeless to expect fair results

"by clearing and planting 50 acres of this land unless the land is very "heavily and repeatedly manured with slag-phosphates, say half a ton "of the phosphates to the acre. I pointed out many years ago, about "1897, the very adverse effects of the remarkable deficiency of phos-"phoric acid in these soils on the nature and composition of the grasses "and especially on the cattle which in many cases fail to thrive on them. "This deficiency in phosphates is specially characteristic of the Berbice "section of the Cattle Trail in the vicinity of which Mr. Melville has "made unsuccessful results at fattening cattle. The total phosphoric "acid varies in these soils from .0001 to .0005 per cent.—a practically "hopeless position.

"I am not in full agreement with Mr. Mullin regarding results of "inbreeding. I consider that the defective character of many of the "cattle is due to scarcity of nutritious food, especially during their youth, "caused by poverty of the soil generally and especially by its deficiency "in phosphoric acid. The soil deficiencies result in defects in quality "of the herbage especially in content of proteids, of mineral matters and "of the food-accessories classed as vitamins, and thus failure to breed "and the production of calves of defective vitality which succumb in "early youth is due directly to the poverty of the soil. It is useless "expecting high grade cattle to withstand the effects of the very inferior "grazing to which even indigenous cattle are apt to succumb."

This view was also held by Follett-Smith in his report on an investigation of the soils at Waranama (*Agr. Jl.*, British Guiana, 1930, Vol III. No. 3, p. 142) but he advocated the regular feeding of bone-meal to the stock, on the grounds that manuring of pastures would probably prove uneconomic.

There are two main factors involved in any plan to feed minerals to these cattle. The first is, of course, cost of transport, and the second is that it may not be profitable to feed minerals to the low-grade stock, since the improvement in quality might not be sufficiently great to raise their market value. On the other hand, if the grade of stock is being raised, the mineral deficiencies would probably be a limiting factor, and a comparison between mineral-fed animals and those fed on natural pastures only might be one between life and death, and thus the cost of transport would be amply repaid.

5. The Hilly Forest Country Bordering the Savannahs.

In the north the Rupununi savannah region is bordered by the Pakaraima Mountains, while the southern boundary is the Karawaimentau range, of which Marudi Mountain is at present the only accessible part. The northern and southern savannahs are separated by the Kanaku Mountains, a range which runs roughly East to West. As the natural trend of development from the savannah region would be into these hills, their geological structures and soil types are of considerable importance.

The Pakaraima Mountains.

The Pakaraima Mountains have generally been regarded as a more or less barren tableland, or a series of plateaux, consisting entirely of Kaieteurean Sandstone. Recent geological surveys have shown that within these mountains are extensive intrusions of basic igneous rocks which give rise to soils entirely different from those on the gritty Kaieteurean sandstone. While the foundation of the range is the Kaieteurean Sedimentary Series, intrusive sills and large dykes have block-faulted the structure into a complex patchwork of sedimentary and igneous outcrops. It is significant that nearly every geological traverse in this region (there are, unfortunately, only a few) shows large outcrops of basic or intermediate igneous rock, and thus the view can no longer be held that the surface rock is almost entirely sedimentary in origin. The extent to which soils derived from igneous rock occur is unknown, but the region is well worthy of further investigation in view of its favourable climate.

There was no opportunity to visit this region during the present survey, but in 1935 Follett-Smith and Frampton did a 200-mile journey up the Ireng valley to Tawailing Mountain, across the Yawong River to Kurukubaru, then over the Chiung River to Tumong Mouth, and by Chenapowu to Kaieteur. They report (*Agr. Jl.*, British Guiana, 1935, p. 155) that, generally speaking the soils of the Pakaraima range which they examined were of low fertility. "The open hills consist of buff coloured sands or loams of acidic reaction and the surface is almost entirely covered with quartz boulders and pebbles. In other places the hills consist of an acidic red clay covered by a layer of ironstone gravel. The mountain tops are usually covered with an infertile white sand, and on descending one passes through a belt of acidic brown sand and then a belt of acidic red clay to the creek bed. Many of the mountain slopes are forest covered, but here and there elevated savannahs are encountered. Some of these, such as the Echilibar, the Kato, and the Chiung savannahs, are extensive."

Two soil samples collected from open elevated savannahs (Kato and Chiung) were analysed by Follett-Smith, and his results are given in Table III (Appendix E379 and 380). The analytical figures were interpreted as follows: "The soil from the Kato savannah is a markedly acidic sandy loam. The amounts of organic matter, lime and readily available phosphate are low. It possesses an adequate amount of potash. The soil from the Chiung savannah is a markedly acidic sand. The contents of organic matter, lime, potash and readily available phosphate are low."

Clay samples were taken from the head of the Tumong River and from the plateau between Mikroparu and Chenapowu, and the results of their analyses are also given in Table III (E381 and 382). Follett-Smith says : " The soil collected at the head of the Tumong is a highly acidic red clay, that collected on the plateau between Mikroparu and Chenapowu is a markedly acidic yellow clay. Both soils are well supplied with organic matter and potash, but are deficient in lime and readily available phosphate. While they

might produce fair crops under shifting cultivation they are not likely to stand up to continuous cultivation."

In the broad valley of the Yawong River between Wandapatoi and Paramakatoi a considerable area of fertile soil was found. The analytical data for two samples taken from this area are included in Table III (E377 and and 378) and there is no doubt that they show the soil to be of excellent texture and great fertility. No parent rock samples were obtained, but it is likely that the soil is derived from an igneous intrusion. As far as could be judged, it occurs in a band five or six miles wide, but its length could not be estimated.

The Kanaku Mountains.

This range is composed of granitic gneiss and granitised sediments, with intrusive dykes or sills of unknown extent. In a reconnaissance flight over the western half of the range it was seen that there are no elevated savannahs, and the interior of the range consists of rounded hills with steep sides. Thus the whole range seems to be intersected by valleys varying in width, and without terracing it would be dangerous to cultivate the hill slopes. The valleys on the northern side of the range are narrow but the soil is fertile, as can be seen from samples E504 and 505 in Table III, which were taken by Sir Geoffrey Evans during his examination of the Moca-Moca Valley. The hill-wash on the outskirts of the valleys also seems to be favourable for cultivation, samples E501—3 in Table III being from flat land outside the Kumaka valley. Thus there is room for a certain amount of development on the flat lands near the mountains and in the narrow valleys which open to the north. The southern valleys are much wider, but were considered by Follett-Smith to be less fertille. He says "The soils of the foothills of the southern side of the Kanaku Mountains do not seem to possess the degree of fertility associated with those of the north-western foothills, but are preferable to those of the open savannahs." He examined soil samples from the mouth of the Saurap valley and from Toroquara creek, and found them to be "of fair fertility," capable of supporting good crops of padi.

The wide valley of the Rupununi River, where it cuts through the Kanaku range, offers an attractive field for agricultural development. It was seen from the air in a reconnaissance flight, and numerous subsidiary valleys lead in from the hills on both sides. These latter valleys are rather narrow on the northern side of the range but they are broader towards the south. Sir Geoffrey Evans visited the main valley, and was impressed by the potentialities of the soil for permanent agriculture. He took a series of soil samples at Makaparima, near a farm belonging to Mr. John Melville, and the analytical data are given in Table III (E507-514). The samples range from a light loam to a heavy clay, and are all practically neutral in reaction (pH 6.4–6.8) with abundant organic matter and nitrogen. There is, however, a deficiency of phosphate which would have to be corrected; lime and potash seem to be adequate.

An igneous intrusion is marked on the geological maps near Makaparima, and it is probable that the fertile red soil is derived from this basic rock. This is the only intrusion marked in the Kanaku range, but it is likely that there are many others which have not been found. A detailed geological survey of this district would be of great value in further soil investigations, as the petrology of the area may be more complex than is indicated at present.

Marudi Mountain.

Little is known of the Karawaimentau range, but the geology of Marudi Mountain, at its south-western end, was examined in 1934 by Dr. D. R. Grantham. He found the area to be composed largely of intensely metamorphosed sediments, with hornblende schists and epidiorites forming the highest ground. It is believed that the schist and epidiorite represent remnants of beds once lying on the basement gneiss and were invaded later by biotite granite, which also occurs in the gneiss.

It can be seen from this that the geology of the area is not simple, and the only rock recorded which would give rise to a fertile soil is the epidiorite, the extent of which is not known. A fertile red soil does occur on the higher parts of the hill (about 1,500 feet) and deep profile pits were available at gold workings on Dr. Godfrey Davidson's claims, 18 miles from the edge of the savannah. One of these cuttings showed 20 feet of rich chocolate-coloured soil, while the other had about 10 feet of this soil overlying 10 feet of brown sand. In both places the soil was lying on gold-bearing quartz gravel, and thus the red soil may have been deposited as hill-wash. Table III (E533-542) gives the analytical figures for serial samples from one of these cuttings, which had been opened for about four months. The fertility of this soil could be judged by the fact that Dr. Davidson had an excellent garden in a 10-acre forest clearing which had been cultivated continuously for six years without signs of exhaustion. It is said that there are many such areas of fertile red soil in the district, but the hilly nature of the land renders it difficult to judge how useful it would be for agriculture. It might even be suggested that "controlled erosion" might be tried, in an attempt to wash the fertile soil from pockets in the hills on to the flats below.

6. The Berbice River And The Cattle Trail.

The Berbice River.

Sir Geoffrey Evans made a brief survey of the Berbice River as far as Takama, 100 miles from the mouth. He found that "for the first 20 miles from the mouth of the river the land consists of lowlying flats typical of the silts and clays of the coastal sugar belt. Above this the soils become gradually lighter and more sandy, and the fringe of the riverain deposits, which are now covered with bush and forest, become narrower. Behind this stretch of forest the open savannahs stretch in either direction. As far as Fort Nassau, which is about 50 miles from the sea, they consist of what is

known as "clay savannahs." At Torani creek on the right bank of the river the savannah comes right down to the riverside, and an opportunity was taken to ride for a short distance over it." The soil of the wide riverain flat about 2 miles below Fort Nassau was sampled, and E526 and 527 in Table IV show it to be a highly acidic loam, with fairly high organic matter and average nitrogen. Further sampling was carried out at a spot 1½ miles due east from the bank, where the savannah is higher. Samples E528—530, Table IV, prove that this soil is much more sandy on the surface and, although the subsoil (3-4 feet) contains a higher percentage of clay, it does not answer to the term "clay savannah." Deep ploughing might improve the texture of this soil sufficiently to allow intensive cultivation, or alternatively orchard crops might be suitable, with irrigation and manuring.

In a bend of the river about 75 miles from its mouth a group of about 20 settlers are cultivating the land, with sweet potatoes as their main crop. The soil of this district was sampled at Kimbia, and E524 and 525 of Table IV indicate that it is an acidic light loam of fair fertility.

Another set of samples, top and subsurface soil, was taken in an Indian reservation about 4 miles up the Wikki creek, which enters the Berbice River on the right bank opposite Takama. This soil, E522 and 523 of Table IV, is a highly acidic loam which, though poor in appearance, is being used by Indians and settlers all along the middle Berbice River. When manure is applied it yields fair crops, and thus it might respond to a system of crop rotation which is designed to maintain the organic matter at a high level.

Previous reports on the soils of the Berbice River area include one by Sir John Harrison, (unpublished) after a visit in 1913, and one in 1931 by Mr. Follett-Smith (also unpublished) on a reconnaissance soil survey of eight plantations which were cultivated by the Dutch settlers in the early part of the eighteenth century.

In summarizing his findings, Harrison says: "The topography of the lands immediately bordering the upper tidal reaches of the Berbice River is such as to ensure their fertility. I am certain that with skilful planting and scientific soil conservation this relatively narrow district will be found one of the most fruitful, if not the most fruitful, in British Guiana. It may be regarded as a river alluvial belt lying on previous sandy clay subsoils produced by the decomposition of various igneous rocks (gneiss, granite, hornblende schist, &c.) *in situ.*"

Harrison also visited an abandoned cacao plantation at Kumaka, about which Mr. B. Howell Jones had eulogized in 1884. He found giant trees still growing luxuriantly, although they were bearing few pods owing to lack of pruning. He says: "Now many of these giant cacaos have fallen but along each fallen trunk new trees, many of them 30 to 40 inches in diameter, have sprung. The cacao appeared to me after very careful examination to be all of one type and to be quite pure in type. It is the strain of type formerly known as golden Caracas, probably the best cacao in the world."

Sir Geoffrey Evans visited this estate and found trees sixty feet high with enormous trunks, but they were covered with Witch Broom.

Follett-Smith carried out a soil survey of the estates of Maria Henrietta, Landstroom, Peereboom, Kumaka, Philipsburg, New Caracas, Doornboom and Osterbeck, which are situated about 90 miles from the mouth of the river. He noted four main soil types in the area :

(a) A markedly acidic *riverside loam,* which appears to be well suited to the requirements of slow-growing crops such as citrus, cacao, coffee and coconuts, but is not sufficiently fertile to permit continuous cultivation of provision crops unless artificial or green manuring is practised. It occurs in this vicinity as a strip about half a mile wide on either bank of the river.

(b) A *clay soil* which is periodically inundated, and supports a flora of manicole, truli and cocorite palms. It occurs as a strip in the rear of the riverside silt. In places the bush has been cleared and rice cultivation is carried on, but there are no facilities for drainage and irrigation.

(c) A *brown lateritic sandy loam* which at present is open savannah country with occasional forest growth, and it might be suitable for citrus cultivation. It occurs to the west of Kumaka at a distance of about 200 yards from the river.

(d) A *sand hill soil type,* similar to that found at Wauna Experiment Station, North West District. Experiments with citrus and other perennial crops have not been very successful at Wauna, probably because transport facilities did not permit the regular application of dressings of manure.

The Cattle Trail.

In 1919 a detailed survey of the cattle trail from Takama on the Berbice River to Canister Falls on the Demerara River, a total of 92 miles, was carried out by Mr. A. A. Abraham, and a report on the soil samples was prepared by Sir John Harrison as a Government paper (Combined Court No. III of 1925). The inspection was done by means of cross lines 5 miles in length cut at intervals of approximately 5 miles on either side of the trail, with intermediate lines 2½ to 3 miles long. The country is a succession of hills ranging from 100 to 600 feet in height, composed of two types of soil, white sand and nut brown to red sand. The white or grey sands can be divided into two sub-types—Muri sand and Wallaba sand, both of which are deficient in vegetable matter, are lacking in retentive power for water, and are therefore of no potential agricultural value. Inspection of this class of sand from which timber had been removed showed the most unproductive and barren aspect from a farming point of view. The nut brown to red sand is also too deficient in clay to be suitable for agriculture, and its only agricultural capability seemed to be the raising of two crops of cassava, yielding a return of 75% less in the second crop compared with the first.

Harrison suggests that this sandy area which is crossed by the cattle trail consists largely of residual quartz-grains derived from the weathering of quartz-porphyry, or of sand eroded from the Kaieteurean Sandstone formation, which lies on quartz-porphyry near the Demerara River sections of the trail. His conclusions on the soil survey are: " Dealing as a whole with the soils collected " during the cattle trail survey they can only be described as quartz sand pass- " ing into very sandy soils, and into mixtures of quartz-sand with leached-out " lithomarge or kaolin. The soils have been thoroughly impoverished of the " constituents necessary for soil fertility and, as savannah soils elsewhere in the " Guianas were described by Humboldt, their areas are among the " Deserts of "South America " I can describe them only as hopelessly barren except in "cases where their subsoil waters may be held up at depths of 18 inches or so " from the surface. In such latter cases certain forest trees may flourish, " while economic plants which require for their growth a very light soil may do " fairly well for a short period ".

Abraham also mentions the lowlying banks of the streams which flow through the country. These form narrow strips of land, the greatest width being only 400 feet. No soil samples were taken from these areas, as they were considered to be impracticable for farm lands, owing to the fact that they are flooded for the greater part of the year.

With regard to the soils of the forest country between Kurupukari and Surama, Harrison had to rely on the observations of others, and he concludes that large areas along the trail in the Burro-Burro Valley are composed of sand and clay silt which is fertile and well watered. But these low places are so deeply flooded during the rainy season that even the passage of cattle is prevented, and in the absence of drainage they would be unsuitable for cultivation. This periodical inundation could be remedied by thoroughly clearing the Burro-Burro River and its tributaries of the innumerable fallen trees which obstruct their courses and back up the water on to the adjoining valley lands.

7. The North West District.

The only definite information available on the soils of the North West District was published (Chem. Bull. No. 1. Dept. of Agri.) in 1930 by Follett-Smith, who made a detailed soil survey of an area of 156 square miles, bounded by the Barima, Aruka, Aruau and Yarakita Rivers. He found three main soil types: "pegasse" (*i.e.*, peat) swamps covering 103 square miles; sand hills covering 40 square miles; and lateritic clay soils covering 13 square miles. This survey was carried out with a view to colonisation by the British Guiana Government, but the results of the topographical survey indicated that drainage of the swamp area would be a matter of extreme difficulty and great cost. The pegasse soils were accordingly ruled out of consideration as far as widespread settlement was concerned. The lateritic clay type, though more suitable, occurs to a very limited extent, and on the hillsides it is so shallow that cultivation would not be advisable. The sand hill soil is an acid sand of low organic matter content, and experience has shown that under continuous cropping its fertility is lost within two or three years. An experiment station was set up

on this soil type at Wauna, near the Government Station of Mabaruma, and this has shown over several years of experiment that even perennial crops such as citrus, coconuts and oil palms would require heavy applications of manure in order to produce good crops.

This soil investigation was carried out on land relatively near the coast, where the main problem in agricultural development would be drainage. Yet, of the 7,500 square miles which are included in the North West District, less than 2,000 square miles are coastal swamps and hills. Thus there is over 5,000 square miles of territory which is geologically allied to the interior of the Colony as distinct from the coastal belt. The soils of the interior of the North West District have not been examined in detail, since marketing of produce would be extremely difficult on account of transport costs. The officers of the Geological Survey report that there are large areas of gneissose granite with numerous intrusions of both acid and basic rocks, and their observations indicate that there may be fairly extensive areas which would respond to scientific methods of cultivation. There are numerous Indian gardens, chiefly on the granite, and it is significant that gold workers can "live on the country" for months at a time without suffering from the nutritional diseases which tend to occur in other parts of the forest belt.

Communication in this area is much easier than in the centre and south of the Colony, as the rivers are navigable for small boats and free from rapids, and on the whole it is possible that agricultural settlement based on an industrial centre might be successful. Without local markets it is very doubtful if colonisation would be economic, unless it was carried out on a scale large enough to bear the cost of greatly improved transport facilities.

ACKNOWLEDGMENTS.

Most of the geological information was supplied by Mr. S. Bracewell, Director of the British Guiana Geological Survey, to whom thanks are due for much helpful advice. The soil analyses were carried out by Mr. C. L. C. Bourne, Assistant Chemist, Department of Agriculture, and credit is due to him for the expeditious manner in which they were completed.

APPENDIX.

Notes On Analytical Methods.

(1) *Mechanical Analysis.* Robinson's method (Imp. Bur. Soil Sci. Tech. Comm. 26, 1933) was employed, the silt being calculated by subtracting from 100 the sum of the sand fractions, clay, loss by solution and organic matter.

In the analysis quoted from Follett-Smith's survey the Index of Texture was determined by Hardy's method (Jr. Agr. Sci. 1928, p. 252).

(2) *Reaction* (pH) Quinhydrone electrode, using 10 gms. soil in 40 ccs. water, left standing overnight. The KCl exchange reaction was also determined but is not given in the tables.

(3) *Organic Matter* = % carbon x 1.724. The carbon was estimated by Hardy's wet combustion method (Jr. Agr. Sci. 1929, p. 727).

(4) *Nitrogen.* Kjeldahl's method, using as catalyst a mixture of copper sulphate, potassium sulphate, and selenium.

(5) *Available Phosphate.* Truog's method (Jr. Amer. Soc. Agron. 1930 p. 874). The results are expressed as parts per million air-dry soil.

(6) *Exchangeable Bases.* Leaching with N 2 acetic acid, the results being expressed as milligram equivalents per 100 gms. air dry soil. Lime (CaO) was estimated as oxalate, and potash (K 0) as the chloroplatinate.

TABLE I.

Soils of the Essequibo Basin.

Soil. No.	Depth	MECHANICAL ANALYSIS (Air Dry Soil).						pH	% Organic matter	%Nitrogen	Available P_2O_5 (Truog) p.p.m.
		Moisture	Coarse Sand	Fine Sand	Silt (by diff.)	Clay	Loss by soln.				
Apoteri—Sandy alluvial soil.											
E 484	0—6 ins.	0.3	77.0	16.1	Nil	5.5	0.4	5.1	0.7	0.028	Nil
E 485	6—12 ins.	0.5	72.5	15.1	0.8	10.0	0.4	4.7	0.7	0.027	Nil
E 486	12—18 ins.	0.5	76.2	10.7	1.4	9.5	1.2	4.6	0.5	0.022	Nil
E 487	18—24 ins	0.5	77.3	6.9	0.9	13.5	0.4	4.4	0.5	0.018	Nil
E 488	24—30 ins	0.6	66.8	7.2	1.8	22.5	0.6	4.5	0.5	0.021	Nil
E 489	30—36 ins.	1.0	49.6	7.7	2.7	37.3	0.9	4.2	0.8	0,027	Nil
Massara—red soil overlying granite.											
E 479	0—3 ins.	2.8	33.9	16.2	9.8	29.5	2.2	6.3	5.6	0.287	110
E 480	3—6 ins.	2.5	32.5	17.0	8.2	34.2	2.1	6.0	3.5	0.167	120
E 481	6—9 ins.	2.0	30.1	18.1	8.6	36.5	1.9	5.7	2.8	0.119	128
E 482	9—12 ins.	1.7	30.4	17.7	12.8	34.0	1.7	5.8	1.7	0.066	110
E 483	12—15 ins.	1.7	26.6	19.6	14.2	35.5	1.1	5.9	1.3	0.067	118
Composite 0—6 ins. Exch. bases, mg. eqvs. /100 gms. Lime 9.55 Potash 0.41											
2 miles from Massara—red soil over epidiorite.											
E 477	0—3 ins.	2.9	16.8	19.8	8.8	43.7	0.9	5.6	7.1	0.407	23
E 478	3—6 ins.	2.9	18.9	16.9	9.1	44.5	1.8	6.1	5.9	0,324	15
Composite 0—6 ins. Exch. bases, mg eqvs. 100 gms. Lime 9.6 Potash 0,19											
Oronoque Falls, New River—red soil.											
E 549	0—6 ins.	1.7	46.3	18.9	0.9	29.0	0.7	4.2	2.5	0,120	trace
E 550	6—12 ins.	1.8	42.5	17.6	2.6	33.2	0.6	4.3	1.7	0.081	10
E 551	12—18 ins.	1.8	41.1	18.2	1.9	35.0	0.7	4.3	1.3	0,074	trace
E 552	18—24 ins.	1.9	38.7	18.1	1.8	37.2	0.6	4.5	1.7	0.090	trace
Composite 0—12 ins. Exch. bases, mg. eqvs. /100 gms. Lime 0,12 Potash 0.30											
Savkin's Island, Essequibo River—soil under *Orbignya sagotii.*											
E 547	0—6 ins.	0.25	67.2	24.0	5.2	2.5	0.2	5.0	0.7	0.039	Nil
E 548	6—12 ins.	0.45	55.9	30.5	3.0	9.5	0.2	4.8	0.5	0.034	trace

TABLE II.

Soils of the Rupununi Savannahs.

Soil No.	Depth	MECHANICAL ANALYSIS (Air Dry Soil)						pH	% Organic matter	% Nitrogen	Available P_2O_5 (Truog) p.p.m.
		Moisture	Coarse sand	Fine sand	Silt (by diff.)	Clay	Loss by soln.				
					Manari—sandy soil.						
E 490	0—3 ins	0.5	32.9	47.8	3.1	14 3	0.3	4.8	1.1	0.035	Nil
E 491	3—6 ins.	0.4	32.0	45.9	5.3	15.0	0.6	5.0	0.8	0.028	Nil
E 492	6—12 ins	0 4	28.6	46.9	3.9	19.0	0.6	4.7	0.6	0.022	Nil
E 493	12—18 ins.	0.4	25.7	47.6	6.7	19.0	0.2	4.8	0.4	0.015	Nil
E 494	18—24 ins.	0.5	23.3	48.5	3.8	23.3	0.3	5.0	0.3	0.010	Nil
E 495	24—30 ins.	0.5	21.4	48.8	3.6	25.0	0.4	5.1	0.2	0.011	Nil
E 496	30—36 ins.	0.4	20.5	46.0	2.4	30.0	0.5	5.0	0 2	0.011	Nil
E 497	36—42 ins.	0.4	20.0	43.1	3.3	32 8	0.2	4 9	0.2	0.010	Nil
E 498	42—48 ins.	1 0	16.6	41.8	9.1	30 8	0.5	4.9	0.2	0.017	Nil
E 499	48—54 ins.	1.1	15.0	41.5	12.9	28.5	0.8	5.0	0.2	0.014	Nil
		Composite 0—6 ins. Exch. bases. mg. eqvs. /100 gms. Lime 0.34 Potash 0.09.									
				Annai—mile 179½ on cattle trail.							
E 516	0—6 ins.	1.5	39.3	36.2	9.3	9 3	0.8	4.0	3.6	0.122	14
E 517	6—12 ins.	0 8	38.6	37.6	4.0	15.3	1.2	4.4	2.5	0.063	10
				Annai—½ mile East of Government Rest House.							
E 518	0—6 ins.	0.9	14.6	51.8	15.0	15.0	1.0	4.7	1.7	0.071	10
E 519	6—12 ins.	0.8	15.2	52.9	15.8	13 3	0.7	4.6	1.3	0 062	trace
				Wariwau—Aishelton—flat land							
E 531	0—6 ins.	1.4	7.1	34.5	25.0	27.8	1.6	4.5	2.6	0.101	16
E 532	6—12 ins.	1.3	8.0	32.9	21 7	33 0	1.4	4.3	1.7	0 070	14
				Manari—flat land near creek.							
E 543	0—6 ins.	0.8	5.5	62.0	14.9	14.3	0.5	4.5	2 0	0 076	Nil
E 544	6—12 ins.	0 8	9.0	52.9	15.6	19.5	0 5	4 3	1.7	0 062	Nil
E 545	12—18 ins.	1.0	17.8	40.8	12.4	26.7	0.6	4.4	0.7	0 035	Nil
E 546	18—24 ins.	0.7	28.1	41.3	5.7	23.5	0.3	4 4	0.4	0.018	Nil
		Composite 0—12 ins. Exch. bases. mg. eqvs. /100 gms. Lime 0.20 Potash 0.11.									

TABLE III.—*Soils of the Hilly Forest Country Bordering the Savannahs.*

Soil No.	Depth	MECHANICAL ANALYSIS (Air Dry Soil) Moisture	Coarse sand	Fine sand	Silt (by diff.)	Clay	Loss by soln.	pH	% Organic matter	% Nitrogen	Available P_2O_5 (Truog) p.p.m.
				Pakaraima Mountains. (Follett-Smith)							
E 379	(Kato)	Index of	texture (%	moist. at	sticky pt.	− ½ sand	= 16	4.8	0.8	0.049	10
E 380	(Chiung)	" "	"	"	" "	" "	= 5	5.1	1.0	0.060	10
E 381	(Tumong)	" "	"	"	" "	" "	= 46	4.7	6.0	0.341	10
E 382	(Mikroparu)							4.8	10.3	0.108	10
E 377	(Yawong)	" "	"	"	" "	" "	= 48	8.3	3.2	0.256	72
E 378		" "	"	"	" "	" "	= 41	8.1	3.6	0.288	10
				Kanaku Mountains.							
		Moca—Moca Valley.									
E 504	0— 6 ins.	4.2	14.8	35.0	9.7	30.8	2.4	6.9	3.1	0.182	Nil
		Exch. bases mg. eqvs./100 gms. Lime 7.03 Potash 0.54 Magnesia 2.8									
E 505	0— 6 ins.	2.3	27.6	40.5	4.3	20.8	2.1	6.1	2.4	0.133	Nil
		Exch. bases mg. eqvs./100 gms. Lime 2.07 Potash 0.27 Magnesia 1.72									
		Hill-wash.									
E 501	0— 6 ins.	2.4	29.5	34.1	8.5	20.0	1.9	6.4	3.6	0.185	Nil
E 502	6—12 ins.	1.9	34.1	30.7	12.7	16.5	2.2	6.5	1.9	0.108	Nil
E 503	12—18 ins.	1.9	36.4	28.2	7.5	23.0	1.4	6.5	1.6	0.095	Nil
		Rupununi Valley—14 miles N. of Sand Creek Village.									
E 507	0— 6 ins.	1.7	43.5	23.9	11.0	15.2	1.9	6.4	2.8	0.154	Nil
E 508	6—12 ins.	1.8	40.2	24.1	5.8	25.5	1.3	6.3	1.4	0.085	Nil
		Composite 0—12 ins. Exch. bases, mg. eqvs./100 gms. Lime 3.0 Potash 0.35									
		Rupununi Valley—flat land 20 miles N. of Sand Creek Village.									
E 509	0— 6 ins.	2.1	28.4	26.5	12.5	24.0	2.7	6.4	3.8	0.188	Nil
E 510	6—12 ins.	1.9	29.6	27.2	10.5	27.8	1.2	6.5	1.8	0.106	Nil
		Composite 0—12 ins. Exch. bases, mg. eqvs./100 gms. Lime 4.39 Potash 0.25									
		Rupununi Valley—1 mile N. of Kurupawau.									
E 511	0— 6 ins.	4.1	12.1	11.7	10.1	53.5	2.9	6.8	5.6	0.291	trace
E 512	6—12 ins.	3.3	10.4	9.3	8.7	64.5	1.2	6.6	2.6	0.140	Nil
		Composite 0—12 ins. Exch. bases, mg. eqvs./100 gms. Lime 3.79 Potash 0.12									
		Rupununi Valley—near Makaparima									
E 513	0— 6 ins.	2.4	37.9	26.2	4.6	23.0	1.9	6.3	4.0	0.186	15
E 514	6—12 ins.	2.3	34.0	23.9	5.1	31.5	1.9	6.0	1.3	0.088	Nil
				Marudi Mountain—Pancake Creek.							
E 533	0— 6 ins.	1.8	15.6	26.2	...	54.7	1.1	7.8	1.9	0.151	trace
E 534	6—12 ins.	1.6	13.7	23.7	14.7	43.8	1.2	7.2	1.3	0.104	Nil
E 535	12—18 ins.	1.6	11.5	20.0	9.8	55.5	0.7	6.7	0.9	0.070	Nil
E 536	18—24 ins.	1.5	10.3	18.3	8.6	59.7	0.9	6.3	0.7	0.055	Nil
E 537	24—30 ins.	1.8	9.9	15.7	8.0	63.5	0.6	5.9	0.5	0.045	Nil
E 538	30—36 ins.	1.6	7.7	14.5	7.8	67.0	0.9	5.8	0.5	0.041	Nil
E 539	36—42 ins.	2.0	9.0	16.3	11.9	59.7	0.7	6.0	0.4	0.032	Nil
E 540	42—48 ins.	1.8	9.7	17.1	5.1	64.0	1.8	6.3	0.5	0.024	Nil
E 541	48—54 ins.	1.7	11.3	17.9	2.5	64.7	1.5	6.3	0.4	0.018	Nil
E 542	54—60 ins.	1.7	12.1	19.3	10.7	55.0	1.0	6.4	0.2	[illegible]	Nil

TABLE IV.

Soils of the Berbice River Area.

Soil No.	Depth	MECHANICAL ANALYSIS (Air Dry Soil) Moisture	Coarse sand	Fine sand	Silt (by diff.)	Clay	Loss by soln.	pH	% Organic matter	% Nitrogen	Available P_2O_5 (Truog) p.p.m.
					Anchor Ranch—2 miles below Fort Nassau						
E 526	0—6 ins.	1.1	Nil	55.9	29 3	10.0	1.5	4.8	2.2	0.095	Nil
E 527	6—12 ins.	1.5	Nil	55.7	26.4	14.0	1.2	4.7	1.2	0.055	Nil
					Anchor Ranch—1½ miles due E. from bank.						
E 528	0—6 ins.	1.2	37.0	32.4	13.0	12.8	1.1	4.6	2.5	0.078	Nil
E 529	6—12 ins.	1.3	36.7	32.1	13.6	13.5	1.2	4.4	1.6	0.055	Nil
E 530	3—4 ft.	1.3	29.9	31.3	9.3	26.8	1.0	5.0	0.4	0.021	Nil
					Kimbia—secondary forest.						
E 524	0—6 ins.	0.9	Nil	65.7	27.0	3.5	0.9	5.0	2.0	0.120	13
E 525	6—12 ins.	0.4	Nil	69.8	22.5	6.3	0.5	4.7	0.5	0.035	Nil
					Wikki Creek						
E 522	0—6 ins.	1.4	Nil	68.8	15.8	11.0	1.0	4.5	2.0	0.127	trace
E 523	6—12 ins.	1.3	Nil	66.5	16.3	14 7	0.7	4.6	0.5	0.035	Nil
		Composite 0—12 ins. Exch. bases, mg. eqvs./100 gms. Lime 0.78 Potash 0.26									

MINERAL DEFICIENCY AND CATTLE RAISING IN BRITISH GUIANA.

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1. THE RUPUNUNI SAVANNAHS.

The savannah country which borders Brazil between latitude 2° and 4° N. covers some 5,000 square miles, and is ecologically part of the immense savannah land of Northern Brazil. The Kanaku mountain range, rising to 4,500 feet, divides the area equally, and gives rise to a network of creeks and streams which eventually join the two water systems of the region, the Takatu and Rupununi rivers. Thus the area is well-watered, and even in the dry season, when the rivers are low, the cattle can obtain sufficient water, while Ité palms (*Mauritia flexuosa*) and low bush along the creek beds provide shade for the animals during the day.

Climatically, therefore, this area is suitable for cattle, and at present it carries over 50,000 head. Grazing is not controlled to any great extent, and the prevalence of bone-chewing shows that there is a serious deficiency of phosphate in the grasses. This is confirmed by chemical analysis, and Tables I and II show that these pastures are even more deficient in lime and phosphate than areas in Kenya, South Africa, Falkland Islands and the United States of America in which mineral deficiency proved to be the limiting factor in stock raising. The grass from Mt. Shiriri which shows a high lime content (5%) is probably associated with a narrow outcrop of marly rock, and the area covered by grass of this type is too small to be important to the cattle industry as a whole. Apart from this single species, the grasses of the savannah are deficient in minerals to an extent which would render intensive stock-raising almost impossible, and improvement of breed, except possibly by Zebu types, would lead to numerous diseases which are known to be caused directly or indirectly by lack of minerals.

The samples of Wynne grass in the same table show the result of introducing new grasses. This species was planted in the North West District and gave 0.5% lime and 0.3% phosphate. The same planted in the Rupununi District gave 0.1% lime and 0.04% phosphate. This indicates that the mineral deficiency cannot be corrected by introducing new pasture grasses, and soil analyses have also shown that the necessary elements are not present in sufficient quantity.

Experiments in South Africa (15) and in Kenya (5) proved that deficiencies of lime and phosphate can be corrected by regular feeding of bone meal, or by the application of fertilizers to the grazing areas. In this connexion it is interesting to note that as early as 1897 Sir John

Harrison realized that phosphate deficiency is an important factor in the cattle industry of the Rupununi District, and he advocated the application of basic slag at the rate of 6 cwts. per acre. With a rainfall of over 60 inches per annum, falling mainly in 6 months, this method of supplying phosphate would be wasteful, but, apart from this, the great transport difficulties render even the feeding of bone meal an expensive item. River communication with Georgetown is so difficult, on account of rapids, that the freight charges to the Rupununi savannahs average 10--12 cents per lb.

As a result of these transport difficulties, the Rupununi ranchers have not been able to fence their lands adequately or to correct the mineral deficiency. The open range system has worked surprisingly well, since the cattle have multiplied from a handful introduced prior to 1900. They live in a semi-wild state, but only a few are killed by jaguars and snakes. The grasses are quite tender when they spring up after burning, but they rapidly become fibrous and unpalatable as they approach maturity.

Taking the difficulties into consideration—poor breed, lack of fencing, lack of minerals, and lack of care for the calves—the animals on the range are in reasonably good condition. Before they reach the Georgetown market, however, they are driven through 180 miles of forest or scrub bush, in which the grazing is too limited to provide more than a starvation ration.

II. THE CATTLE TRAIL.

Prior to 1919, the only market for Rupununi animals was in Brazil, but in that year Mr. H. P. C. Melville was authorised by Government to demarcate a trail from Annai, at the Northern end of the savannahs, past Kurupukari and Canister Falls to Takama on the Berbice River. For the first few miles after leaving Annai the trail is mainly in savannah country, but near 180 miles it enters the forest, and then, apart from a small savannah at Surama it runs through thick forest to about 40 miles. The rest of the trail to Takama is in relatively open country, with low scrub bush.

A careful study of the soils of the cattle trail was made by Sir John Harrison (13), who summarized his findings as follows:—

"Dealing as a whole with the soils collected during the Cattle Trail "Survey they can only be described as quartz-sand passing into very sandy "soils and into mixtures of quartz-sand with leached-out lithomarge or kaolin. "The soils have been thoroughly impoverished of the constituents necessary "for soil fertility, and as savannah soils elsewhere in the Guianas were "described by Humboldt their areas are among the Deserts of South "America."

Thus the problem of providing good grazing for the animals during their passage through the trail is one of the greatest difficulties. Numerous paddocks have been established, but the cost of clearing the forest and of fencing are too high to permit rapid improvements. For some years the trail was managed by the Rupununi Development Company, on a decreasing grant from Government. Since the end of 1934, the trail has been directly under Government control, managed by the District Commissioner, whose varied duties allow him little time for intensive supervision.

With these difficulties in view, it is not surprising that the animals are driven through the trail under starvation conditions. The soils are too poor to support rapid growth of indigenous grasses and the paddocks are eaten out and trampled down by the first drive of the season. This might be corrected by controlled grazing in larger subdivided paddocks, but that would require more supervision and higher maintenance costs, and the market value of the animals in Georgetown is too low to justify this.

Since the main requirements of the animals on the trail are protein and carbohydrate to provide energy, the mineral content of the trail grasses is of secondary importance. It is here that new grasses would be of great value, but the experimental work would necessitate more supervision than is possible under the present system.

III. The Intermediate Savannahs.

The term "intermediate savannahs" is applied to those grazing areas which are situated in the Berbice, Canje, Abary, and Corentyne river systems, sufficiently far from the coast to be clear of the clay and pegasse soils which consitute the chief sugar and rice lands.

An intensive examination of the Waranama ranch, about 100 miles up the Berbice River, was made in 1930 by Bone, Follett-Smith, and Martyn. Their reports (2, 7, 14) show that the feeding conditions in this area are too poor to support breeding stock (see analyses in Table III). Bone (2) mentions that animals from the Rupununi savannahs are kept on this ranch until they are required for the Georgetown market. They arrive at Waranama in a tired condition after their journey through the trail, but they soon recover from this and are then in fair condition. They retain this condition provided that they are not kept on Waranama for more than a few months, but if there is delay in despatching them to the market they lose condition and become emaciated.

Bone further reports that one hundred head of cows and heifers were transferred to Waranama from the Rupununi District, in an attempt to keep breeding stock on this ranch. They lost condition rapidly and died. There is nothing in the analytical figures in Tables I and III to explain why animals breed quite rapidly on the Rupununi savannahs, but become emaciated if they are kept for long periods at Waranama.

In this connexion, one point in Bone's report is of particular interest. Mr. Haly, then Manager of the ranch, stated that animals graze on burned areas for a few days only, and that they leave these areas while there is still a good spring of young grass. In a recent conversation, Mr. Haly mentioned that he had attempted to force some animals to graze a burned area by fencing them in. After about a week, the animals would not eat, and thus his attempt to institute close grazing on a rotational plan was not successful. Bone suggests that the animals lick the ash in addition to cropping the young grass, and that their taste for the grass disappears when the ash is exhausted.

On Table III analytical figures are given for grass at different stages of growth.. These samples were taken from an area in which the forest had recently been cleared, and the grass is much higher in mineral content than that of the open savannah. There is no definite drop in the contents of lime and phosphate up to six weeks of age, but the nitrogen content of the youngest grass is much higher than that of the others. Palatability and protein content may thus be of some importance but this is not sufficient to account for the unsuitability of the area for breeding stock.

A possible solution of the problem is found by comparing the "effective" grazing areas of the Rupununi savannahs with those of Waranama. The Rupununi Development Company holding on the Southern savannah covers 2,000 square miles, on which there are at present some 40,000 head of cattle. This works out at 20 animals per square mile or one animal to 32 acres, which seems to leave room for heavier stocking. But the cattle graze almost exclusively on the grass along the creek beds, where conditions are more suitable for rapid growth, and they can scarcely be persuaded to leave these areas even when they are over-grazed. The samples on Table I were taken from higher land, and, although no analyses are available for the "creek bed" grasses there are indications that the soil is less barren on these low-lying lands.

In the Rupununi savannahs the proportion of creek bed areas is less than one hundredth of the whole, but, taking this figure as a maximum, we have one animal to 0.32 acres of "effective" grazing. This is definitely overstocking with the herd at its present size, particularly as this pasture is available only in the drier parts of the year when the floods recede. This point has been emphasized by Turner (16) who estimates that less than one-fifth of the grazing area is of value. This, however, must include areas of higher land which are grazed for only a week or so after burning, and therefore cannot be regarded as "effective" grazing, since the animals utilize them only as a last resort. The analytical figures suggest that no animal could exist on the pastures which constitute the bulk of the grazing, and the reason why the cattle always look their best in dry weather may be the fact that the creek bed grasses are available at that time.

At Waranama most of the land is undulating, with a very small area of creek bed grazing land, say one five-hundredth of the total area (*i.e.*, 100 acres in 80 square miles). This means that when a drive of 500 steers arrives from the Rupununi savannahs at the beginning of the dry season the animals find 100 acres of lush grass in addition to the poor grasses of the higher lands (the ranch is now used only for resting steers on their way to the coast). This creek bed area is grazed at the rate of 5 head per acre, and is sufficient to let them regain condition for a time. When this grass is eaten down they will not leave the creek beds except for a few days' grazing on a freshly burned area of higher land. As a result of this they lose condition and eventually become emaciated. It is probable that the breeding experiment referred to above was in addition to the ordinary carrying capacity of the ranch, and thus the animals could only obtain the grass of the higher lands.

We have thus reached the conclusion that the pastures on the higher lands of the Rupununi and Berbice savannahs are valueless for grazing, principally, it would appear, on account of their extreme deficiency of lime and phosphate. A supplementary mineral ration might render these available for grazing, and so greatly increase the "effective" grazing areas. On account of the high cost of transport, mineral rations are at present out of the question on the Rupununi savannahs, but the easily accessible Berbice savannahs present a better prospect in this respect. Experiments are now being started on two Berbice ranches in which steers which have come through the trail will have access to a mixture of bone meal and salt, in an attempt to recondition them for sale in Georgetown. The chief difficulty will probably be the wildness of the animals, and there may be some difficulty in persuading them to take the minerals.

IV.—The Coastlands.

Numerous papers on the livestock problems of the coastlands (1, 3, 4, 6, 9, 10, 11, 12) have shown that there are great difficulties with fencing and drainage. Fencing is complicated by flooding during the wet season, when the animals must have higher land on which to rest, and many areas of normally good grazing are practically useless for long periods every year. The high cost of drainage on the low-lying coastlands would not be repaid by beef cattle, and even dairying is heavily handicapped by this expense.

Table IV gives analytical figures for several species of coastland grasses, the mineral content of which is much higher than that of the interior savannah grasses. While mineral supplements would probably be of value in fattening stock for the market, there is no evidence of acute deficiency on the average pasture. At the Government Stock Farm a mineral mixture is regularly fed to all stock, and the high lime and phosphate contents of the pasture grasses is a direct result of this. Most of the analyses recorded are of samples from Government land, but there are no symptoms of mineral deficiency on any of the coastal grazing areas. Thus cattle-raising on the coast is not handicapped by lack of minerals, and the factors which limit the industry are outside the scope of this discussion, namely, fencing, communal agistment areas, and drainage.

It is noticeable that some of the coastland grasses are higher in minerals than others, but it should be pointed out that a pure stand of a single species would not be advisable. As the seasons vary there is a succession of pasture species which maintain a good sward, and one single species would not flourish under the rapid alternations of flood and drought which are accentuated by the heavy clay soils. The variation of mineral content through the year is shown in Table V, in which Follett-Smith (8) shows the analyses of monthly samples from a new paddock in the Government Stock Farm. This pasture is lower in minerals than the grasses from the Stock Farm in Table IV, since this area had not been grazed by mineral-fed animals. The somewhat surprising regularity of mineral supply is due partly to a fairly even distribution of rain throughout the year, and partly to the succession of pasture species which balance the climatic variations.

REFERENCES.

(1) BONE, T. (1930). Cattle in the coastal belt. Agric. J. British Guiana, Vol. III, p. 35.

(2) — (1930). Investigation of ranching problems of the Waranama Savannah, Berbice River. Agric. J. British Guiana, Vol. III, p. 160.

(3) — (1934). Cattle on the coast. Agric. J. British Guiana Vol. V, p. 200.

(4) DASH, Prof. J. S. (1935). Livestock problems in British Guiana. Agric. J. British Guiana, Vol. ~~VII~~, VI p. 100.

(5) ECONOMIC ADVISORY COUNCIL (1931). Sixth Report of the Committee on the mineral content of natural pastures. H.M. Stationery Office, London.

(6) FOLLETT-SMITH, R. R. (1930). Minerals in the pasture grasses of British Guiana. Agric. J. British Guiana, Vol. III, p. 39.

(7) — (1930). The Report of an investigation of the soils and of the mineral content of pasture grasses occurring at Waranama Ranch, Berbice River. Agric. J. British Guiana. Vol. III, p. 160.

(8) — (1934). Divisional Reports, Department of Agric., p. 100.

(9) FRASER, H. A. (1935). Dairy Cattle in British Guiana. Agric. J. British Guiana. Vol. VI, p. 71.

(10) — and BONE, T. (1935). An experiment with dairy cattle in British Guiana. Agric. J. British Guiana, Vol. VII, p. 222.

(11) — (1938). A grade dairy herd. Agric. J. British Guiana. Vol. IX, p. 153.

(12) FULTON, A. M. (1931). Fencing and its significance in relation to local livestock problems. Agric. J. British Guiana, Vol. IV, p. 5.

(13) HARRISON, SIR J. B. (1925). Memorandum on the soils of the Cattle Trail. Combined Court of B.G. Sessional Paper No. 11/1925.

(14) MARTYN, E. B. (1931). A botanical survey of the Rupununi Development Company's ranch at Waranama, Berbice River. Agric. J. British Guiana, Vol. IV, p. 18.

(15) THEILER, SIR A., GREEN, H. H., and DU TOIT, P. J. (1924) Phosphorous in the livestock industry. J. Dept. of Agric. Union of South Africa. Vol. 8, p 460.

(16) TURNER, H. E. (1938). A short history of the Rupununi Savannahs with special reference to the livestock industry. Agric. J. British Guiana. Vol. IX, p. 230.

ANALYSIS OF GRASSES *

(Figures are per cent. oven-dry weight).

TABLE I.

RUPUNUNI SAVANNAH GRASSES.

	LIME (CaO)	PHOSPHATE (P_2O_5)	NITROGEN
Mixed pasture, Mt. Shiriri	0.24	0.15	—
Legume (*Desmodium* ?) Mt. Shiriri	5.00	0.40	—
Mixed pasture, Kurasabi	0.12	0.02	—
Mixed pasture, Paramakatoi	0.09	0.05	—
Trachypogon plumosus, Bon Success	0.14	0.03	—
Melinis minutiflora (Wynne grass)			
Rupununi District	1.10	0.04	—
North West District	0.48	0.26	—

* Abstracted from various papers quoted in the text and from Departmental records.

TABLE II.

OTHER GRASSES FOR COMPARISON.

	LIME (CaO)	PHOSPHATE P_2O_5	NITROGEN
Pasture, Molo, Kenya (mineral deficient)	0.48	0.22	0.95
Pasture, Nakuru, Kenya (mineral deficient)	0.41	0.30	0.89
Prairie hay, Minnesota, U.S.A. (mineral deficient)	0.58	0.23	...
Pasture, Falkland Is. (mineral deficient)	0.29	0.54	1.95
Veldt pasture, S. Africa (mineral deficient)			
Sampled 10th Nov. 1919 ...	0.60	0.31	3.15
„ 15th Jan. 1920 ...	0.22	0.50	2.21
„ 19th April „ ...	0.11	0.46	0.78
„ 8th June „ ...	0.09	0.59	0.64
Poor hill pasture, Great Britain ...	0.56	0.60	2.54
Cultivated pasture, „ „ ...	1.00	0.74	2.83

TABLE III.

GRASSES OF INTERMEDIATE SAVANNAHS.

	LIME CaO	PHOSPHATE (P_2O_5)	NITROGEN
Pasture, Yawakuri, Cattle Trail	0.14	0.09	1.19
Scleria microcarpa, Orealia, Corentyne River	0.05	0.03	0.64
Axonopus attenuatus, Corentyne River	0.13	0.07	0.54
Stenophyllus coniferus, Corentyne River	0.10	0.07	0.87
Mixed pasture, Toorani, Berbice River	0.09	0.12	0.76
Axonopus attenuatus, Waranama, Berbice River	0.17	0.01	0.50
Capriola dactylon, Waranama, Berbice River	0.32	0.14	1.09
Panicum barbinode, Waranama, Berbice River	0.25	0.15	1.31
Axonopus aureus, Waranama, Berbice River	0.20	0.10	0.47
"Pan Grass" Waranama, Berbice River (mixed pasture in water holes)	0.21	0.09	0.55
Trachypogon plumosus, Waranama, Berbice River			
1 week after burning } bush recently cleared	0.12	0.33	2.16
3 weeks after burning } bush recently cleared	0.09	0.22	1.11
6 weeks after burning } bush recently cleared	0.17	0.34	1.11
Open savannah, mature grass	0.12	0.02	0.48
Open savannah, 1 weeks after burning	0.12	0.04	0.74

TABLE IV.

COASTLAND GRASSES.

	LIME (CaO)	PHOSPHATE (P_2O_5)	NITROGEN
Government Stock Farm.			
Mixed pasture	0.30	0.92	1.38
Capriola dactylon (Bahama Grass)	0.49	0.22	1.18
Panicum barbinode (Para Grass)	0.25	0.22	1.21
Commelina nudiflora (Zeb Grass)	0.93	0.28	1.80
Asystasia gangetica (Demerara Primrose)	0.82	0.82	3.83
Paspalum conjugatum (Sour Grass)	0.45	0.86	2.07
Paspalum virgatum (Razor Grass)	0.45	0.95	2.29
Indigofera endecaphylla	0.84	0.81	3.01
Tripsacum laxum (Guatemala Grass)	0.15	0.58	1.03
Georgetown Experiment Station.			
Pennisetum pupureum (Elephant Grass)	0.28	0.03	0.85
Alysicarpus vaginatus (Horse Weed)	1.15	0.55	3.36
Phaseolus calcaratus (Rice Bean)	0.62	1.37	3.45
Uba cane stalks	0.07	trace	0.09
Uba cane leaves	0.28	0.76	1.15
Andropogon nodosus	0.26	0.17	1.16
Mahaica Savannah.			
Homalocenchrus hexandrus (Fine Grass)	0.18	0.13	1.21
Essequibo.			
Phaseolus semi erectus	1.53	0.82	2.78
Kitty.			
Desmodium barbatum	0.85	0.47	3 15

TABLE V.

SEASONAL VARIATIONS IN COASTLAND PASTURE.

		LIME (CaO)	PHOSPHATE (P_2O_5)	NITROGEN
Mixed pasture, Govt. Stock Farm (new paddock)				
Sampled	3. 8.33	0.47	0.49	1.19
	12. 9.33	0.43	0.45	1.18
	3.10.33	0.55	0.49	1.28
	13.11.33	0.61	0.49	1.37
	4.12.33	0.39	0.50	1.31
	4. 1.34	0.34	0.42	1.01
	6. 2.34	0.14	0.45	1.51
	9. 3.34	0.31	0.48	1.12
	4. 4.34	0.35	0.43	1.23
	11. 5.34	0.43	0.47	1.07
	5. 6.34	0.50	0.49	1.54
	4. 7.34	0.49	0.55	1.46

IRRIGATION-MANURIAL TRIALS WITH SUGAR CANE ON FLOOD-FALLOWED FRONTLAND.

BY

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INTRODUCTION.

The general layout of British Guiana cane lands has been described by Deerr (1921), Williams (1931), Follett-Smith (1933) and Cooper (1937), and it is assumed in this paper that readers are familiar with such peculiarities of the layout as affect the subject under discussion. Suffice it to say that, owing to the flat, low-lying nature of the land, the irrigation methods in vogue in other cane countries are hardly feasible here.

Although the total precipitation in most years would be ample for the production of satisfactory crops, its distribution is faulty, and dry periods frequently occur when the rainfall for twelve to eighteen successive weeks may average less than an inch per week. At such times recourse is had to irrigation, which is effected by cutting the dam bed of a given field facing the main navigation canal and allowing the water to flow in. In some instances it is possible thus to cover the internal beds by gravitational flow, but more usually the cut has to be closed when the water ceases to flow in and a portable pump (Skinner, 1936) is used to complete the operation.

The water, on entering, first fills the drains and collectors, then gradually rises over the lower parts of the internal beds and finally covers the entire field, except the highest portions of the peripheral beds which act as retainers. With a combination of gravity flow and the usual 6,000 gallons-per-minute pump, the complete flooding of a 10-acre field will take from ten to eighteen hours.

The water is allowed to remain undisturbed for twelve to twenty-four hours and is then released into the main drainage canal. The period of retention is shortest in young plants and or on lighter soils and longest in ratoons, older canes and/or on stiffer soils. It takes from ten to fifteen hours completely to run out of a ten-acre field. Thus, the highest portions of the cultivated soil remain covered from twelve to twenty-four hours while the lowest parts may be covered for as much as 24-36 hours.

The frequency with which such irrigations are given varies, according to the number of pumps and the amount of water available, from estate to estate, but one may say that, in general, an effort is made to treat any given field at least at monthly intervals during dry spells.

The question having arisen as to whether more frequent irrigations are desirable and whether the cane could advantageously use more nitrogen if irrigated more frequently, tests were laid down on four estates to throw some light on the matter.

THE EXPERIMENTS.

Topographical conditions and the method of irrigation precluded the use of small replicated plots within a field. Three fields were therefore used on each estate. Each of the three fields was irrigated according to a definite schedule, arbitrarily denominated 'low', 'medium' and 'high', *i.e.* :—

Low : Irrigated whenever the rainfall for the preceding 28 days totalled less than 2 inches.

Medium : Irrigated whenever the rainfall for the preceding 14 days totalled less than 2 inches.

High : Irrigated whenever the rainfall for the preceding 7 days totalled less than 1 inch.

As the experiments were conducted on four estates, there were four fields at each irrigation level. In each field, replicate plots were laid down to compare the effect of 3 and 6 cwt. of sulphate of ammonia per acre, and the fields were treated and harvested as plant canes, first and second ratoons.

The dates of planting and harvest for the respective estates are shown in Table I.

TABLE I.

Dates of Planting and Harvests of Irrigation-Manurial Trials.

Estate	Fields	Planted	Harvested as					
			Plants		First Ratoons		Second Ratoons	
			Date	Age, Months	Date	Age, Months	Date	Age, Months
Skeldon	119/80 121/80 123/80	29 II.36	6 IV.37	13¼	9.VIII.38	16	27.VII.39	11½
Port Mourant	2 P.M L 3 P.M.L. 4 P.M.L.	12.XII 35	3 II 37	13¾	24 II 38	12¾	24.II.39	12
Rose Hall	6 T. 8 T 10 T.	4.VII 36	4.V 37	10	8.IV.38	11¼	22.III 39	11½
Bath	21 D. 20 D 19 D.	17.VII.36	22 VII.37	12¼	21.VII.38	12	29.VI.39	11¼

From the above it will be seen that trials at the four sites were not planted and harvested simultaneously. In consequence the canes at the various sites encountered the dry periods at different ages. Since, in commercial practice,

planting is carried on for some two-thirds of the year, it was felt that something nearer a general answer would be secured by having the experimental blocks (a group of three fields on a given estate) harvested at different dates.

The number of irrigations given the various fields and the rainfall at the four estates are compared in Table II.

TABLE II.

Rainfall and Number of Irrigations at the Various Sites.

Estate.	Frequency of Irrigation	Plants: Rain-fall during Cycle in	Plants: No. of Irriga-tions.	First Ratoons: Rain-fall during Cycle, in.	First Ratoons: No. of Irriga-tions.	Second Ratoons: Rain-fall during Cycle in.	Second Ratoons: No of Irriga-tions.
Skeldon	Low	86.33	3	140.92	3	81.07	1
	Medium		10		9		5
	High		18		16		10
Port Mourant	Low	72.41	5	61.06	3	102.95	3
	Medium		11		6		7
	High		16		14		14
Rose Hall	Low	42.14	6	120.73	2	93.60	2
	Medium		14		7		7
	High		29		17		14
Bath	Low	88.43	6	124.28	2	92 35	1
	Medium		12		4		3
	High		21		9		7

THE RESULTS.

The varying frequencies of irrigation were without definite differential effects on the cane quality and it will suffice if we consider only the yields of cane, as shown in Table III.

TABLE III.

Effect of Varying Irrigation Frequencies on Cane Yield.

ESTATE.	Frequency of Irrigation.	Tons Cane per Acre								
		Plants			First Ratoons			Second Ratoons		
		3 cwt. S.A.	6 cwt. S.A.	Mean.	3 cwt. S.A.	6 cwt. S.A.	Mean.	3 cwt. S.A.	6 cwt. S.A.	Mean.
Skeldon	Low	51.25	54.51	52.88	31.38	34.01	32.69	27.15	35.08	31.11
	Medium	41.50	49.38	45.44	29.15	32.74	30.94	24.90	31.56	28.23
	High	46.89	52.58	49.73	29.70	29.81	29.75	18.96	25.75	22.35
Port Mourant	Low	53.46	54.09	53.77	36.26	44.61	40.43	24.21	29.02	26.61
	Medium	48.48	49.06	48.77	36.99	43.20	40.09	25.93	31.16	28.54
	High	47.98	47.74	47.86	40.58	48.31	44.44	26.74	31.86	29.30
Rose Hall	Low	28.92	26.33	27.62	21.18	25.91	23.54	24.06	28.46	26.26
	Medium	22.89	23.71	23.30	24.52	27.51	26.01	25.27	30.55	27.91
	High	27.30	29.89	28.59	29.91	35.68	32.79	29.64	32.77	31.20
Bath	Low	41.31	41.30	41.30	31.63	31.77	31.70	29.70	31.48	30.59
	Medium	35.14	41.87	38.50	28.93	33.42	31.17	27.51	31.77	29.64
	High	40.30	43.33	41.81	24.69	24.36	24.52	25.01	24.54	24.77
Combined Results	Low	43.73	44.06	43.90	30.11	34.07	32.09	26.28	31.01	28.64
	Medium	37.01	41.01	39.01	29.90	34.22	32.06	25.90	31.26	28.58
	High	40.62	43.39	42.00	31.22	34.54	32.88	25.09	28.73	26.91

Summary of Effects.

	Plants	First Ratoons	Second Ratoons
Skeldon	In favour of 'Low'	Diff. not significant	In favour of 'Low'
Port Mourant	Diff. not significant	Diff. not significant	Diff. not significant
Rose Hall	Diff. not significant	In favour of 'High'	Diff. not significant
Bath	Diff. not significant	In favour of 'Low'	In favour of 'Low'
Combined Results	In favour of 'Low'	Diff. not significant	Diff. not significant

In view of the above it must be concluded that, under local conditions, there is no advantage in irrigating cane more frequently than once in 28 days (when the rainfall in that period has not exceeded 2 in.).

No support was found for the suggestion that with more frequent irrigation heavier doses of nitrogen could advantageously be used.

Acknowledgments.

Grateful thanks are expressed to Mr. R. R. Follett-Smith who assisted in designing the tests, to the sugar estate authorities concerned for their co-operation, and to the Staff of the Sugar Experiment Station for their collaboration.

References.

1. Cooper. St. G. C. (1937). Cane Growth Studies in British Guiana.—Agric. J. Brit. Guiana, VIII, pp. 6—7.
2. Deerr, N. (1921). Cane Sugar, p. 126.
3. Follett-Smith, R. R. (1933). The Flood-Fallowing of Cane Fields in British Guiana.—Trop. Agric., X, p. 91.
4. Skinner, C. R. (1936). The Screw or Propeller Pump as used for Irrigation and Flood-Fallowing in British Guiana.—Agric. J. British Guiana. VII, p. 165.
5. Williams, C. H. B. (1931). An Experiment with Bamboo Underdrainage for Sugar Cane.—Agric. J. Brit. Guiana, IV, p. 33

RECENT INTRODUCTIONS OF ORNAMENTAL PLANTS IN THE BOTANIC GARDEN, GEORGETOWN.

BY

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and

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The introduction of new ornamental plants to the Botanic Garden with a view to increasing its beauty and adding to its interest is an important item in the general management of the Garden. Introductions are effected in a number of ways, and generally on an exchange basis. Sometimes a selection of seed is sent by allied institutions with the hope that it may yield material of value and a request made for other varieties, usually specified, in return. The Garden publishes a seed exchange catalogue, listing plants from which seed can be obtained. On other occasions, persons interested in the Garden, especially individuals who have seen it when visiting Georgetown, send seed of plants that they think will be useful acquisitions. Further introductions are made by keeping in touch with Botanic Gardens in other parts of the world and especially with our neighbours.

In addition, when ordering seeds and bulbs of the commoner bedding plants, annual and perennial, from commercial firms, new items are purchased for trial from time to time. To obtain a large selection of seed is therefore not difficult, but this only constitutes a small part of the problem. To begin with, seed which takes a long time in transit may not germinate at all on arrival, or only yield one or two plants; but if successful germination is obtained, the plants are basketed and kept in the nursery until ready to put out. The next problem is the selection of a suitable site. Apart from the fact that, without overcrowding, it is now difficult to find a site for large trees or palms in the Garden except where a gap is caused by a plant dying, or a stretch of water for a new aquatic where it will not be crowded out, it is also often necessary to try and find a 'high' spot for a new plant which may not be able to stand 'wet feet.' 'High' spots in a garden laid out on a totally flat area of heavy clay soil, a few inches only above sea level, are naturally at a premium. In addition the soil of the Garden is exceptionally heavy, and contains none of the 'caddy' found in some other parts of Georgetown. Many plants therefore can make no headway under these conditions, and either die soon after planting out, or are never as effective as they would be in a more congenial habitat. Others on the other hand turn out unexpectedly well. It is therefore sometimes difficult to choose the best place for a new introduction when its size and

appearance at maturity are problematical. Finally, our rather uncertain seasons of rainfall and very constant temperature are by no means well suited to bring about the best floral display from plants suited to a climate where there are marked and regular changes of season.

However, despite these difficulties, many new species are introduced to the Garden; some to become permanent inhabitants, others lasting for shorter periods, and the remainder of this note deals with some of the more striking introductions made during the last few years.

Trees, and more especially flowering trees, naturally constitute some of the most conspicuous features in the Garden, and our most attractive introduction in recent years has been the pink-flowered *Cassia nodosa*, obtained from Trinidad. It grows quickly in the Garden, is a beautiful sight when in flower (from May onwards) and a well shaped tree with abundant foliage when not blossoming. There is a plant near the North West corner and one by the No. 3 lake. Another rather striking introduction from the same source was the small 'Orchid Flower' tree, *Monodora tenuifolia*, of which a plant was established a short way up the avenue, on the South side, after a previous introduction had failed. Perhaps the most remarkable of all, when in full flower, is the Carib wood, *Sabinea carinalis*, obtained from Dominica, another small tree, which during its short flowering period is covered in bright red blossoms. There is a plant North of No. 2 lake and another on the avenue, but it is not very well suited to our soil and several other plants have died. Two other small trees with most beautiful blossom are *Erythrina variegata* var. *orientalis*, with deep scarlet flowers, which was obtained from a Georgetown garden, and *Erythrina senegalensis*, with flowers similar to the Oronoque, which came from the Arnold Arboretum, Cuba. Both are to be seen in the Flower Garden and blossom during dry weather. *Cordia sebestena*, several shades of which were obtained from Barbados, is also to be seen in Regent Street. The flowers are pretty, but the tree does not blossom as profusely as it does in the drier West Indian Islands. *Markhamia Hildebrandtii*, a yellow-flowered tree recently introduced from Kenya, promises well. Other small flowering trees that are new include *Gliricidia sepium* from Puerto Rico and some Bauhinias (*acuminata Kurzii*, *tomentosa* and *violacea*) from the United States Department of Agriculture. New foliage trees that seem to be promising include *Enterolobium cyclocarpum*, *Mesua ferrea* and *Parkia Roxburghii*, all obtained from Ceylon, *Acacia auriculaeformis*, sent us from the United States Department of Agriculture. and the smaller *Acacia sphaerocephala*, obtained from Dominica.

The Georgetown Garden is well known for its collection of Palms, begun at the outset by G. S. Jenman. Recent successful additions include *Butia capitata* and *B. yatai*, *Chamaerops humilis*, *Phoenix dactylifera* and *Washingtonia robusta*, obtained from Coconut Grove Palmetum, Florida, and Mr. David Barry of California, *Coleospadix oninensis*, *Geonoma gracilis* and *Roystonea borinquena* from Trinidad and *Euterpe stenophylla*, *Martinezia erosa*, *M. Lindeniana* and *Korthalsia grandis* from other sources. It is as yet too early to say whether a number of other recent palm introductions will become successfully established or not.

Before turning to smaller plants, reference may also be made to the 'Male' bamboo, *Dendrocalamus strictus*, which has been re-introduced from Puerto Rico and Florida, and is becoming well established.

Some of the most striking acquisitions have been among flowering shrubs and climbing plants. *Cassia biflora*, recently obtained from Barbados, is a pretty little shrub, quick growing, on the stems of which are borne masses of yellow flowers, and which blossoms for several months on end. It has proved very suitable to local conditions and is somewhat reminiscent of Broom when in flower. *Calliandra Guildingii*, a quick-growing shrub, sometimes almost attaining the size of a small tree, was sent from Trinidad. It is extremely quick growing, bearing tufts of pink and white flowers, and there are now a good many plants in the Garden, and in other parts of Georgetown. There is one opposite the Garden entrance and another by the aviary. Trinidad has also been a source of several other new shrubs. Two new Hibiscus varieties—'Sunset' and another with copper-coloured leaves, have come from there; also a white Poinsettia (which has made rather poor growth), the blue-flowered *Clerodendron ugandense*, *Mussaenda erythrophylla* (another rather delicate plant in the Garden) and the pink and white varieties of *Barleria cristata*. Another *Barleria* (*B. lancifolia*), with yellowish-orange flowers, was obtained from the Arnold Arboretum. *Tinnea aethiopica* sent from Jamaica is a re-introduction. One of the 'Bottle Brushes', *Callistemon lanceolatus*, from Queensland, is new. Two small shrubs which have proved most successful as border plants are *Clerodendron fallax* with large leaves and striking heads of scarlet flowers, and *Crossandra undulaefolia*, with orange red flowers, received from Dominica. A new pale lilac shade of the King (Queen) of Flowers, *Lagerstroemia indica*, was obtained from a Georgetown Garden.

Passing on to the climbing plants, some of the new Bougainvillaeas have perhaps proved the most attractive innovations, especially the variety 'Helen McLean' from Trinidad and the very similar 'Louis Wathen' from Ceylon, with 'flowers' showing a range of shades from reddish-orange to rose pink; these with another pink variety, 'Lady Wilson' from Trinidad, are all sub-varieties of *B. spectabilis* var. *Rosa Catalina*. A very deep tinted variety of the common purple Bougainvillaea, growing on an arch by the Garden's office, also came from Trinidad. A number of striking and interesting Aristolochias were obtained from the Arnold Arboretum, including *argyroneura*, *elegans*, *ridicula* and the enormous 'Duck Flower', *A. grandiflora*, which has however a most unpleasant odour of carrion, to attract flies. These, with *A. ringens*, from the United States Department of Agriculture, are grown in and about the nursery and rockery. *Argyreia speciosa*, known as the Cephalic Vine in the West Indies, is a large leaved and vigorous climber, with purple flowers, growing now on the vegetable garden fence. It was obtained from Jamaica and is most suitable for hiding walls and palings. Several pretty Ipomoeas have been introduced, including the white flowered semi-climbing *Ipomoea arborea*, received from Mexico, some pale blue varieties obtained from commercial firms, a yellow species, *Ipomoea pterodes*, possibly indigenous, and a lilac-coloured species sent us from Abyssinia. Unfortunately, some of these introduced

Ipomoeas do not seed in the Garden and so are difficult to reproduce. Two indigenous climbers, the Kaieteur Vine, *Banisteria* (?) *ciliata* and *'black-eyed Susan'*, *Thunbergia alata*, of which there is both an orange-yellow and a white form, have proved very useful. *Cryptostegia grandiflora* and *Ruellia speciosa* both of which had formerly grown in the Garden and been lost have been re-introduced, the former from Suddie and the latter from Georgetown. Finally, a double flowered form of the Pink Coralita, obtained from Barbados, is of interest, though not such a vigorous grower as the ordinary form.

In the beds of the Flower Garden and around the Nursery several new varieties of bedding plants have appeared in the last few years, and most conspicuous among these have been some new Cannas, the first suckers of which came from Jamaica, and which have been gradually worked up so that now they can be massed in beds and borders. The most successful of these newer varieties have been the Salmon Pink 'Sheherziade', and the rather similar 'Hungarin', the cream white 'Eureka', the orange yellow and red varieties 'Prince of Orange' and 'Gyphaete', and the Red 'Ambassador', the latter with purplish leaves. The scarlet 'President' has been in the Gardens for a long time. A purple Salvia from Bermuda and the Barbados Lupin, *Crotalaria zanzabarica*, have also been most successful, and *Strobilanthus isophyllus*, with purplish-blue funnel-shaped flowers, sent us from the Arnold Arboretum, has found itself well adapted to local conditions and seeds readily. In addition, new varieties of the common annuals and perennials are often obtained from the recognised commercial seedsmen.

The shaded Rockery has received considerable attention of late, and in it are a number of new plants. *Browallia speciosa*, which grows splendidly under light shade, was first introduced by Lady Northcote. A variety of shades of *Achimenes* were obtained from Messrs. Suttons, and have been most satisfactory. Several indigenous *Gesneriaceae*, including species of *Episcia*, *Tussacia pulchella* and another species of this genus, also collected in the interior, add colour to the beds. From a collection of Amaryllids received from Florida, so far *Zephyranthes Ajax* alone has flowered several times, but some of the others may yet blossom. A large yellow-flowered species of *Zephyranthes* from Barbados has also flowered recently and a variety of *Hippeastrum solandriflorum* from Bermuda. A plant of the Jacobean Lily, *Sprekelia formosissima*, was acquired from a local garden, and one plant of the White Anthurium Lily has been obtained from Trinidad. With difficulty one or two plants of a white Arum from Bermuda have recently been coaxed into flower.

In conclusion attention must be drawn to two valuable new aquatic introductions, namely *Victoria cruziana*, and *Nelumbo luteum*. Seeds of the former, which is a native of the Amazon, were obtained from the New York Botanic Garden, and the plant has been established in a small trench immediately south-east of the 'oval', on the Avenue. The leaves and flowers are similar to, but considerably smaller than those of *V. regia*. *Nelumbo luteum*, the yellow Lotus Lily, is indigenous to Florida, but the

seed was obtained from Jamaica, and after establishing one plant in a trench running at right angles to the North of the North Serpentine Drive, near No. 3 lake, the plant spread rapidly and in a few months had filled half of the trench. This yellow lotus was introduced into the Garden many years ago, but crossed with the Pink Lotus—*N. nucifera*. The pink lotus proved dominant, and finally the yellow species was lost entirely but not before the pink had lost its pure deep shade, which was replaced by a paler colour, varying in degree, the result of the cross, and which is now to be seen in most of the lakes and trenches of the Park lands.

A few years ago the true pink was re-introduced from Berbice, and is established in another trench, running off the North Serpentine Avenue, near the Apiary.

CATALOGUE OF THE LEPIDOPTERA RHOPALOCERA (BUTTERFLIES) OF BRITISH GUIANA—(*Concluded*).

BY

ARTHUR HALL, F.R. Ent. S.

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521. Papilio pausanias.

P. pausanias, Hewitson, Trans. Ent. Soc. 1852, p. 22, t. 6, f. 2.

Demerara River; Mt. Roraima. A very rare species and a good mimic of *Heliconius clytia* and its allies.

522. P. ariarathes menes.

P. ariarathes menes, Rothschild & Jordan, Nov. Zool. XIII, p. 672, t. 8. f. 57 (1906).

Bartica; Berbice; Christianburg on the Demerara River; Kamakusa. One of the rarer species.

523. Papilio protesilaus.

P. protesilaus, Linnaeus, Syst. Nat. 1, p. 463, n. 29 (1758).

Demerara River. Sometimes common at certain times of the year but its season seems to be short. Several specimens may sometimes be seen settling together in patches on the banks of rivers, generally in company with a large number of *Catopsilias*.

524. Papilio telesilaus.

P. telesilaus, Felder, Vrh. Zool. Bot. Ges. XIV, p. 301, n. 179, p. 345, n. 90 (1864).

Demerara River; Essequibo River. Sometimes common in company with the preceding species and of similar habits.

525. Papilio glaucolaus leucas.

P. glaucolaus leucas, Rothschild & Jordan, Nov. Zool. XIII, p. 709, t. 9, f. 65 (1906).

Demerara River; Berbice.

526. Papilio molops hetaerius.

P. molops hetaerius, Rothschild & Jordan, Nov. Zool. XIII, p. 711, t. 9, f. 61 (1906).

In the Tring Museum from Demerara.

527. PAPILIO AGESILAUS AUTOSILAUS.
P. autosilaus, Bates, Trans. Ent. Soc. 1861, p. 348.
Essequibo River; Demerara River.

528. PAPILIO DOLICAON.
P. dolicaon, Cramer, Pap. Ex. I, t. 17, C, D (1775).
Demerara River; Takutu; Mackenzie.

Family HESPERIDAE.
Sub-family PYRRHOPYGINAE.

529. PYRRHOPYGE GARATA.
P. garata, Hewitson, Trans. Ent. Soc. 1866, p. 483.
Demerara River; Omai.

530. PYRRHOPYGE PHIDIAS.
Papilio phidias, Linnaeus, Syst. Nat. I, p. 485, n. 164 (1758).
Mabaruma.

531. PYRRHOPYGE DRAUDTI.
P. draudti, Bell, Journ. N. York Ent. Soc. XXIX, p. 435 (1931).
In the British Museum from "British Guiana".

532. PYRRHOPYGE ZELEUCUS.
Hesperia zeleucus, Fabricius, Ent. Syst. III, (1), p. 346, n. 317 (1793).
Demerara River; Kaieteur Falls.

533. PYRRHOPYGE STYX.
P. styx, Moschler, Verh. Zool. Bot. Ges. Wien XLVIII, p. 209.
Friendship, Berbice; Mt. Roraima.

534. PYRRHOPYGE AMYCLAS.
Papilio amyclas, Cramer, Pap. Ex. III, t. 199, F (1792).
Georgetown; Demerara River. Mr. L. D. Cleare informs me that the larva of this species lives upon Guava.

535. MYSORIA VENEZUELAE.
M. venezuelae, Scudder, Rep. Peab. Acad. VI, p. 67 (1872).
Omai; Parika; Mt. Roraima.

536. AMENIS AMRA.
Pyrrhopyge amra, Hewitson, Ex. Butt. IV, *Pyrrhopyge* t. 3, f. 16, 17 (1871).
In the British Museum from "British Guiana".

537. YANGUNA TETRICUS.

Yanguna tetricus, Bell, "Entomologist" LXIV, p. 235 (1931).
The type, the only specimen known to me, came from Mt. Roraima.

Sub-family HESPERIINAE.

538. TARSOCTENUS PAPIAS.

Pyrrhopyga papias, Hewitson, Ex. Butt. II, *Pyrrhopyga*, t. 1, f. 4 (1857).
Carimang River.

539. TARSOCTENUS RUFIBASIS.

T. rufibasis, Mabille & Boull., Ann. Sci. Nat. Paris XVI, p. 24.
Demerara River; Omai.

540. EUDAMUS PROTEUS.

Papilio proteus, Linnaeus, Syst. Nat. I, p. 484, n. 163 (1758).
An abundant species everywhere.

541. EUDAMUS DORANTES.

Papilio dorantes, Stoll, Suppl. Cram. t. 39, f. 9 (1790).
Generally distributed and common.

542. EUDAMUS EURYCLES.

Hesperia eurycles, Latreille, Enc. Méth. IX, p. 750, n. 5 (1823).
Generally common.

543. EUDAMUS SIMPLICUIS.

Papilio simplicuis, Stoll. Suppl. Cram. t. 39, f. 6, 6E (1790).
Another very common and generally distributed species.

544. EUDAMUS PILATUS.

E. pilatus, Plötz, Bull. Mosc. 1881, p. 2.
Georgetown; Demerara River.

545. EUDAMUS LINDORA.

Goniurus lindora, Butler, Trans. Ent. Soc. 1870, p. 491.
In the British Museum from British Guiana.

546. EUDAMUS CATILLUS.

Papilio catillus, Cramer, Pap. Ex. III, t. 260, F, G. (1782).
Bartica; Omai.

547. EUDAMUS ASINE.
E. asine, Hewitson, Descr. Hesp. p. 5, n. 5 (1867).
Quonga.

548. EUDAMUS STYLITES.
E. stylites, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 63, n. 16 (1869).
Quonga.

549. EUDAMUS DORYSSUS.
E. doryssus, Swainson, Zool. Ill. Ins. II, t. 48, f. 2 (1933).
Demerara; Omai; Berbice; Quonga; Carimang River.

550. EUDAMUS ALBIMARGO.
Thymele albimargo, Mabille, Bull. Soc. Ent. Fr. (5), V, p. 213 (1876).
Bartica; Omai; Quonga; Carimang River; Takutu; Kaieteur Falls; Mabaruma. Evidently widely distributed but generally found singly.

551. EUDAMUS VIRESCENS.
E. virescens, Mabille, Bull. Soc. Ent. Fr. 1877, p. 39.
In the British Museum from "British Guiana."

552. EUDAMUS ORION.
Papilio orion, Cramer, Pap. Ex. II, t. 155, A, B (1779).
Demerara; Omai; Kaieteur Falls. A handsome and rather scarce species

553. GONIURUS TALUS.
Papilio talus, Cramer, Pap. Ex. II, t. 176, D (1779).
Demerara; Takutu; Carimang River.

554. GONIURUS COELUS.
Papilio coelus, Cramer, Pap. Ex. IV, t. 243, C, D (1782).
Bartica; Carimang River.

555. PROTEIDES IDAS.
Papilio idas, Cramer, Pap. Ex. III, t. 260, A, B (1782).
Berbice; Friendship; Bartica.

556. ACOLASTUS AMYNTAS.
Papilio amyntas, Fabricius, Syst. Ent. p. 533, n. 384 (1775).
Bartica; Omai.

557. THYMELE FULGERATOR.
Papilio fulgerator, Walch, Naturf. VII, p. 115, t. 1, f. 2a, b (1775)
Generally distributed in forest regions but not very abundant.

558. THYMELE AULESTES.
Papilio aulestes, Cramer, Pap. Ex. III, t. 283, E-G (1782).
Mt. Roraima.

559. THYMELE ENOTRUS.
Papilio enotrus, Cramer, Pap. Ex. IV, t. 364, G, H (1782).
Demerara; Essequibo River; Annai.

560. THYMELE APASTUS.
Papilio apastus, Cramer, Pap. Ex. II, t. 111, D, E (1779).
Single specimens from Bartica and "British Guiana."

561. TELEGONUS CRETEUS.
Papilio creteus, Cramer, Pap. Ex. III, t. 284, C, D (1782).
Georgetown; Berbice; Carimang River; Mt. Roraima.

562. TELEGONUS PARMENIDES.
Papilio parmenides, Cramer, Pap. Ex. IV, t. 364, E, F (1782).
Demerara River.

563. TELEGONUS ALARDUS.
Papilio alardus, Stoll, Suppl. Cram. t. 39, f. 7, 7F (1790).
Bartica.

564. TELEGONUS ANAPHUS.
Papilio anaphus, Cramer, Pap. Ex. II, t. 178, F (1779).
Generally distributed and common.

565. TELEMIADES AMPHION.
Proteides amphion, Hübner, Zubr. Ex. Schmett. f 631, 632 (1832).
Carimang River; Kaieteur Falls.

566. TELEMIADES AZINES.
Eudamus azines, Hewitson, Descr. Hesp. p. 17, n. 31 (1867).
Demerara River; Carimang River.

567. TELEMIADES CERAMINA.
T. ceramina, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 69, n. 5 (1869).
In the British Museum from "British Guiana".

568. TELEMIADES LITTERA.
T. littera, Mabille, Petit. Nouv. Ent. 1877, n. 180.
Kaieteur Falls (A. Hall).

569. CECROPTERUS NEIS.
Cecrops neis, Hübner, Zubr. Ex. Schmett. f 619, 620 (1832).
Berbice; Bartica; Carimang River.

570. CECROPTERUS ITYLUS.
Autochton itylus, Hübner, Zubr. Ex. Schmett. f. 249, 250 (1823).
Parika; Bartica; Demerara.

571. CECROPTERUS AUNUS.

Papilio aunus, Fabricius, Spec. Ins. II, p. 134, n. 618 (1781).

Widely distributed and abundant.

572. ECTOMIS ADOXA.

P. adoxa, Mabille & Bull., Ann. Soc. Ent. Belg. 1878, p. 32.

Bartica. A very rare species otherwise only recorded from Cayenne.

573. PHYSALEA PAUSIAS.

Eudamus pausias, Hewitson, Descr. Hesp. p. 17, n. 29 (1867).

Berbice; Carimang River.

574. NASCUS CAEPIO.

Telemiades caepio, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 68, n. 2 (1869).

Annai; Quonga; Carimang River.

575. BUNGALOTIS SALATIS.

Papilio salatis, Cramer, Pap. Ex. IV, t. 393, E (1782).

Quonga.

576. BUNGALOTIS MIDAS.

Papilio midas, Cramer, Pap. Ex. I, t. 63, G (1779).

A pair of this fine species is in the British Museum from Demerara. Also recorded from Mackenzie.

577. BUNGALOTIS EURIBATES.

Papilio euribates, Cramer, Pap. Ex. IV, t. 393, D (1782).

In the British Museum from "British Guiana."

578. COGIA CALCHAS.

Eudamus calchas, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 68, n. 22 (1869).

Bartica; Quonga.

579. HYDRAENOMIA ORCINUS.

Eudamus orcinus, Felder, Reise Nov. Lep. III, p. 510, t. 71, f. 4, 5 (1867).

A male from "British Guiana" in the British Museum.

580. PARADROS PHOENICE.

Eudamus phoenice, Hewitson, Descr. Hesp. p. 19, n. 35 (1867).

Demerara; Carimang River.

581. PARADROS EOUS.

Eudamus eous, Hewitson, Descr. Hesp. p. 20, n. 37 (1867).
Carimang River.

582. LIGNYOSTOLA CRINISUS.

Papilio crinisus, Cramer, Pap. Ex. IV, t. 300, G, H (1782).
Berbice; Demerara River; Omai; Akyma.

583. HYALOTHYRUS NELEUS.

Papilio neleus, Linnaeus, Syst. Nat. I, p. 488, n. 187 (1758).
Omai.

584. HYALOTHYRUS NITOCRIS.

Papilio nitocris, Cramer, Pap. Ex. IV, t. 293. F, G (1782).
Demerara; Omai.

585. MIONECTES INFERNALIS.

Entheus infernalis, Möschler, Verh. z. b. Wien. XXVI, p. 329, t. 4, f. 21 (1876).
Demerara; Omai; Kaieteur Falls.

586. MARELA TAMYROIDES.

Eudamus tamyroides, Felder, Reise Nov. Lep. III, p. 509, n. 886, t. 70, f. 13, 14 (1867).
Demerara; Carimang River.

587. PHANUS VITREUS.

Papilio vitreus, Cramer, Pap. Ex. IV, t. 365, D (1782).
Bartica; Omai; Carimang River; Kaieteur Falls.

588. PHANUS MARSHALLI.

P. marshalli, Kirby, Proc. Roy. Soc. Dublin, 1880, p. 339.
Bartica. Doubtfully distinct from the preceding.

589. ENTHEUS PRIASSUS.

Papilio priassus, Linnaeus, Syst. Nat. I, p. 487, n. 185 (1758).
Quonga; Carimang River.

590. ENTHEUS GENTIUS.

Papilio gentius, Cramer, Pap. Ex. II, t. 179, C (1779).
Georgetown; Omai; Annai; Carimang River. A fairly common species.

591. ENTHEUS EUMELUS.

Papilio eumelus, Cramer, Pap. Ex. II, t. 156, E (1779).

Carimang River.

592. GRYNOPSIS COELESTE.

Phareas coeleste, Westwood, Gen. Diurn. Lep. t. 78, f. 4 (1852).

This fine and rare species is in the British Museum from the Carimang River and Mt. Roraima.

593. CELAENORRHINUS ELIGIUS.

Papilio eligius, Cramer, Pap. Ex. IV, t. 354, H (1782).

Quonga.

594. CELAENORRHINUS ASTRIGERA.

C. astrigera, Butler, Trans. Ent. Soc. 1877, p. 153.

Quonga.

595. PYTHONIDES MENEDEMUS.

P. menedemus, Godman & Salvin, Biol. Cent. Am. Rhop. p. 362. t. 32 f. 17, 18 (1894).

Demerara; Carimang River.

596. PYTHONIDES CERIALIS.

Papilio cerialis, Cramer, Pap. Ex. IV, t. 392, n, o (1782).

Generally distributed and common.

597. PYTHONIDES ASSECLA.

P. assecla, Mabille, Bull. Soc. Ent. Belg. 1883, p. 76.

Mabaruma. (A. Hall). Marlissa in Berbice.

598. PYTHONIDES LUCULLEA HEW.

Leucochitonea lucullea, Hewitson, Descr. Hesp. p. 46, n. 1 (1868).

Demerara; Carimang River; Kaieteur Falls.

599. PYTHONIDES CONTUBERNALIS.

P. contubernalis, Mabille, Bull. Soc. Ent. Belg. 1883, p. 76.

Kaieteur Falls (A. Hall).

600. ATE LAGIA.

Leucochitonea lagia, Hewitson, Descr. Hesp. p. 47, n. 3 (1868).

Kaieteur Falls (A. Hall). There are also specimens from "British Guiana" in the British Museum.

601. ATE JOVIANUS.

Papilio jovianus, Cramer, Pap. Ex. IV, t. 392, L, M (1782).

Demerara River; Bartica; Carimang River; Kaieteur Falls; Mabaruma. Usually only found singly.

602. SPIONIADES ARTEMIDES.

Papilio artemides, Cramer, Pap. Ex. IV, t. 391, L, M (1782).

Demerara; Mabaruma.

603. PELLICIA TIPHYS.

P. tiphys, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 368, t. 83, f. 6-10 (1894).

Generally common.

604. PELLICIA DIDIA.

P. didia, Moschler, Verh. z. b. Wien. XXVI, p. 341, t. 4. f. 25 (1876).

Parika; Mabaruma.

605. PELLICIA MACAREUS.

P. macarius, Herrich-Schaeffer, Corresp. Blatt Regensb. 1870, p. 160.

Omai; Quonga; Carimang River.

606. PYRDALUS CORBULO.

Papilio corbulo, Cramer, Pap. Ex. IV, t. 354, A (1782).

Carimang River.

607. NISONIADES HERO.

N. hero, Evans, *in litt.*

Described from the Carimang River.

608. CYCLOSAEMIA ANASTOMOSIS.

C. anastomosis, Mabille, Petit. Nouv. Ent. 1878, p. 230.

Carimang River.

609. CYCLOSAEMIA CARIMA.

C. carima, Evans, *in litt.*

Carimang River.

610. CYCLOSAEMIA HERENNIUS.

Papilio herennius, Stoll, in Cramer, Pap. Ex IV, t. 392, E, F (1782).

Demerara River; Marlissa in Berbice.

611. ANASTRUS OBSCURUS.

A. obscurus, Hübner, Samml. Ex. Schmett. (1816-1841).

Demerara; Carimang River.

612. ECHELATUS ROBIGUS.

E. robigus, Plötz, Ex. Schmett. 20, t. 1006.

Quonga.

613. ECHELATUS SEMPITERNUS.

Achlyodes sempiternus, Butler & Druce, Cist. Ent. I, p. 114 (1872).

Bartica.

614. EUDAMIDAS MELANDER.

Papilio melander, Cramer, Pap. Ex. III, t. 270, H (1782).

Carimang River.

615. XENOPHANES TRYXUS.

Papilio tryxus, Cramer, Pap. Ex. IV, t. 334, G, H (1782).

Rather common and generally distributed.

616. ACHYLODES FRIDERICUS.

A. fridericus, Hübner, Zubr. Ex. Schmett. f. 611, 612 (1832).

Generally common.

617. ACHYLODES THIENA.

A. thiena, Plotz, Exot. Schmett. 20, Hesp. t. 957.

Mentioned from British Guiana by Seitz. It is a very obscure species and likely to be overlooked.

618. ANTIGONUS NEARCHUS.

Hesperia nearchus, Latreille, Humb. Bonpl. Obs. Zool. II, p. 135, t. 43, f. 3, 4 (1811-1823).

Bartica. Not common.

619. MILANION HEMES.

Papilio hemes, Cramer, Pap. Ex. II, t. 103, F (1779).

Annai; Berbice; Carimang River; Kaieteur Falls.

620. SEBALDIA BUSIRUS.

Papilio busirus, Cramer, Pap. Ex. III, t. 261, A-C (1782).

Marudi Mtn. Rupununi District (L. J. H. Ashburner).

621. EANTIS THRASO.

Urbanus vetus thraso, Hübner, Samml. Ex. Schmett. (1806-16).

Bartica; Omai; Quonga.

622. TIMOCHARES TRIFASCIATA.

Leucochitonea trifasciata, Hewitson, Descr. Hesp. p. 49, n. 10 (1868).

Carimang River.

623. ELRIETAS ECLIPTICA.

Achlyodes ecliptica, Butler, Trans. Ent. Soc. 1877, p. 114.
Carimang River.

624. DIPHORIDAS PHALAENOIDES.

Urbanus vetus phalaenoides, Hübner, Samml. Ex. Schmett. (1806-16).
A common species in most places.

625. CAMTOPLEURA EBENUS.

C. ebenus, Mabille, Compt. Rend. Soc. Ent. Belg. 1883, p. 14.
Carimang River.

626. CYCLOGYPHA THRASYBULUS.

Hesperia thrasibulus, Fabricius, Ent. Syst. III, (1), p. 346 (1793)
Omai; Mt. Roraima.

627. CYCLOGYPHA TISIAS.

C. tisias, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 423, t. 88, f. 16 (1896).
Mt. Roraima.

628. GORGYTHION PYRALINA.

Helias pyralina, Möschler, Verh. Zool. Bot. Ges. Wien XXVI, p. 343, t. 4, f. 31 (1876).
Widely distributed and very common.

629. PARAMIMAS SCURRA.

Urbanus juvenis scurra, Hübner, Samml. Ex. Schmett. (1806-1816).
Demerara River; Carimang River; Bartica; Kaieteur Falls.

630. CHARIDIA LUCARIA.

Leucochitonea lucaria, Hewitson, Descr. Hesp. p. 50, n. 12 (1868).

631. CHIOMARA MITHRAX.

C. mithrax, Moschler, Verh. Zool. Bot. Ges. Wien, 1878, p. 225.
Demerara River; Bartica.

632. CHIOMARA PUNCTUM.

C. punctum, Mabille, Petit. Nouv. Ent. 1888, p. 229.
In the British Museum from the Demerara River.

633. CHIOMARA ASYCHIS.

Papilio asychis, Cramer, Pap. Ex. IV, t. 334, E, F (1782).

There are specimens in the British Museum labelled "Kingston, Demerara." Possibly Georgetown is meant. It is a common West Indian species.

634. HESPERIA SYRICTHUS.

Papilio syricthus, Fabricius, Syst. Ent. p. 534, n. 394 (1775).

One of the commonest of all butterflies; abundant both in forest and in cultivated places.

635. HELIOPTES ARSALTE.

Papilio arsalte, Linnaeus, Syst. Nat. I, p. 469, n. 67 (1758).

Widely distributed and common, usually in open or cultivated places.

636. HELIOPTES PETRUS.

Brontiades petrus, Hübner, Verz. Bek. Schmett. p. 113 (1816).

Georgetown; Parika; Bartica; Takutu. Less abundant than *H. arsalte*.

Sub-family PAMPHILINAE.

637. HYLEPHILA PHYLAEUS.

Papilio phylaeus, Drurg, Ill. Ex. Ent. I t. 13, f. 4, 5 (1773).

Generally distributed and common.

638. THYMELICUS VIBEX.

T. vibex, Hübner, Zubr. Ex. Schmett. f. 685, 686 (1832).

Widely distributed and sometimes common.

639. THYMELICUS ATHENION.

Talides athenion, Hübner, Samml. Ex. Schmett. (1816-1841).

Another very common species.

640. APAUSTUS GRACILIS.

Ancyloxypha gracilis, Felder, Reise Nov. Lep. III, p. 520, t. 74, f. 28 (1867).

Bartica.

641. ATRYTONE EULOGIUS.

A. eulogius, Plotz, Exot. Schmett. 20, Hesp. p. 608.

Georgetown; Kaieteur Falls.

642. ATRYTONE GLADOLIS.

A. gladolis, Dyar, Insec. Ins. Menstr. II, p. 5 (1914).

Bred by H. W. B. Moore, at Non Pareil Plantation from larva feeding on the shoots of sugar cane.

643. ATRYTONE HEBERIA.

A. heberia, Dyar, Insec. Ins. Menstr. II, p. 5 (1914).

Also bred by H. W. B. Moore at Non Pareil Plantation, the larva likewise feeding upon sugar cane. Neither species is known to me in nature.

644. ZARIASPES MYS.

Urbanus vigorus mys, Hübner, Samml. Ex. Schmett. (1806-1816).

Demerara; Parika; Mabaruma; Mt. Roraima. Like other small species probably common if looked for.

645. ZARIASPES FERRAGO.

Z. ferrago, Plötz, Stett, Ent. Zeit. 1884, p. 163.

In the British Museum from Takutu (Whitely). Seitz gives this name as synonym to *Padraona epictetus* but the specimen in the British Museum is certainly different.

646. PADRAONA EPICTETUS.

Papilio epictetus, Fabricius, Ent. Syst. III, (1), p. 330, n. 252 (1793).

Demerara; Bartica; Parika; Carimang River. A common species.

647. PADRAONA TRYHANA.

P. tryhana, Kaye, Trans. Ent. Soc. 1914, p. 581, t. 30, f. 3.

Bartica; Demerara; Essequibo River.

648. TRIOEDUSA MILVIUS.

T. milvius, Mabille, Gen. Ins. 17d, p. 145.

Takutu.

649. PRENES NYCTELIUS.

Hesperia nyctelius, Latreille, Enc. Méth. IX, p. 746 (1823).

Demerara; Berbice.

650. PRENES SYLVICOLA.

Goniurus sylvicola, Herrich-Schaeffer, Corresp. Blatt. Regensb. XIX, p. 55, n. 13 (1865).

Generally distributed and abundant in cane fields.

651. PRENES OCOLA.

P. ocola, Edwards, Proc. Ent. Soc. Phil. II, p. 20, t. 11, f. 4 (1863).

Berbice; Quonga; Mt. Roraima.

652. PRENES QUONGA.

P. quonga, Evans, *in litt.*

Type from Quonga in the British Museum.

653. PRENES EVADNES.

Papilio evadnes. Cramer, Pap. Ex. IV, t. 343, G, H (1782).

Demerara; Quonga; Takutu; Kaieteur Falls.

654. PRENES NERO.

Hesperia nero, Fabricius, Ent. Syst. Suppl. p. 433 (1798).
Quonga; Mt. Roraima.

655. PARAIDES BRINO.

Papilio brino, Cramer, Pap. Ex. IV, t. 353, E, F; t. 292, C, D (1782).
In the British Museum from "British Guiana."

656. XENIADES ORCHAMUS.

Papilio orchamus, Cramer, Pap. Ex. II, t. 155, E, F (1779).
Annai; Mt. Roraima.

657. XENIADES CHALESTRA.

Hesperia chalestra, Hewitson, Trans. Ent. Soc. 1866, p. 488.
Demerara River; Berbice.

658. TELLES ARCALAUS.

Papilio arcalaus, Cramer, Pap. Ex. IV, t. 391, I, K (1782).
A male from "British Guiana" in the British Museum.

659. THESPIEUS DALMANI.

Hesperia dalmani, Latreille, Enc. Méth. IX, p. 747, n. 48 (1823).
Omai.

660. VACERRA LITANA.

Hesperia litana, Hewitson, Trans. Ent. Soc. 1866, p. 494.
Quonga.

661. NICONIADES XANTHAPHES.

Nisoniades xanthaphes, Hübner, Samml. Exot. Schmett. (1816-1841).
Georgetown; Berbice; Kaieteur Falls.

662. NICONIADES CAESO.

N. caeso, Mabille, Compt. Rend. Soc. Ent. Belg. 1891, p. 88.
Kaieteur Falls; Mackenzie.

663. PHEMIADES PROPERTIUS.

Hesperia propertius, Fabricius, Ent. Syst. III, (1), p. 325, n. 234 (1793).
Demerara; Bartica; Carimang River.

664. RHINTHON CYNEA.

Hesperia cynea, Hewitson, Ann. Mag. Nat. Hist. (4), XVIII, p. 456 (1876).
Bartica.

665. **RHINTHON BISTRIGULA.**

Cobalus bistrigula, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 83, n. 64 (1869).

Quonga.

666. **RHINTHON ALUS.**

Rhinthon alus, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 532 t. 98, f. 4-6 (1900).

Parika (A. Hall).

667. **RHINTHON EREBINA.**

R. erebina, Möschler, Verh. Zool. Bot. Ges. Wien 1878, p. 211.

Kaieteur Falls.

668. **RHINTHON MELIUS.**

Thracides melius, Hübner, Zubr. Ex. Schmett. f. 755, 756 (1832).

Quonga.

669. **RHINTHON MEGALOPS.**

R. megalops, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 533, t. 98, f. 11-13 (1900).

Parika.

670. **RHINTHON ANTHRACINUS.**

R. anthracinus, Mabille. Petit. Nov. Ent. 1877, p. 162.

Quonga.

671. **COBALUS VIRBIUS.**

Papilio virbius, Cramer, Pap. Ex. II, t. 143, G (1779).

Demerara; Carimang River.

672. **COBALUS ARGUS.**

C. argus, Moschler, Verh. Zool. Bot. Ges. Wien. 1878, p. 212 (1878).

Bartica.

673. **COBALUS AETHRA.**

C. aethra, Plotz, Exot. Schmett. Hesp. 20, t. 1399.

Bartica.

674. **COBALUS CANNAE.**

C. cannae, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 83 (1869).

In the British Museum from "British Guiana."

675. **COBALOPSIS DYSCRITUS.**

C. dyscritus, Mabille, Compt. Rend. Soc. Ent. Belg. 1891, p. 95.

Carimang River; Takutu.

676. ONOPHAS COLUMBARIA.

Pamphila columbaria, Herrich-Schaeffer, Corresp. Blatt. Regensb. p. 159 (1870).

Carimang River.

677. PERIMELES REMUS.

Hesperia remus, Fabricius, Ent. Syst. Supp. p. 434 (1798).

Mt. Roraima.

678. EUTYCHIDE CINGULICORNIS.

Cobalus cingulicornis, Herrich-Schaeffer, Prodr. Syst. Lep. p. 82, n. 52 (1869).

Bartica; Quonga; Carimang River; Mt. Roraima. This species seems to be strangely local. I once took four or five specimens off the same *Euphorbia* bush at Bartica but never saw one anywhere else.

679. EUTYCHIDE SUBCORDATA.

Cobalus subcordata, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 82, n. 60 (1869).

Carimang River; Mt. Roraima.

680. EUTYCHIDE ASEMA.

E. asema, Mabille, Compt. Rend. Soc. Ent. Belg. 1891, p. 171.

Takutu.

681. COBALOPSIS EDDA.

Pamphila edda, Mabille, Compt. Rend Soc. Ent. Belg. 1891, p. 170.

Takutu.

682. PHANIS JUSTINIANUS.

Hesperia justinianus, Latreille, Enc. Méth. IX, p. 760 (1823).

Quonga.

683. PHANIS REZIA.

P. rezia, Plötz, Exot. Schmett. 20, Hesp. p. 466.

Bartica. The specimens do not seem to be typical and may belong to a different species.

684. PHANIS ALMODA.

Hesperia almoda, Hewitson, Trans. Ent. Soc. 1866, p. 499.

Quonga.

685. PHLEBODES TIBERIUS.

Apaustus tiberius, Möschler, Verh. Zool. Bot. Ges. Wien 1882, p. 329.

Bartica.

686. Philebodes reticulata.

P. reticulata, Plötz, Ex. Schmett. 20, Hesp. t. 650.
Quonga; Carimang River; Mt. Roraima.

687. Lerema parumpunctata.

Goniurus parumpunctata, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 76, n. 51 (1869).
Berbice.

688. Lerema mooreana.

L. mooreana, Dyar, Insec. Ins. Menstr. II, p. 4 (1914).
Bred at Georgetown by H. W. B. Moore from larva feeding on the shoots of sugar cane. (Dyar).

689. Papias integra.

Pamphilia integra, Mabille, Compt. Rend. Soc. Ent. Belg. 1891, p. 169.
Carimang River.

690. Papias dictys.

P. dictys, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 560, t. 100, f. 12, 13 (1900).
Mabaruma.

691. Papias leucopogon.

P. leucopogon, Plotz, Exot. Schmett. 20, Hesp. t. 287.
Mabaruma.

692. Thargella fuliginosa.

T. fuliginosa, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 565, t. 100, f. 24, 25 (1900).
Parika; Kaieteur Falls. Locally common.

693. Mnasitheus simplicissimus.

Pamphila simplicissimus, Herrich-Schaeffer, Corresp. Blatt Regensb. 1870, p. 159.
Bartica.

694. Mnasatcas uniformis.

Pamphila uniformis, Butler & Druce, Cist. Ent. I, p. 113 (1872).
Georgetown.

695. Vehilius illudens.

Cobalus illudens, Mabille, Compt. Rend. Soc. Ent. Belg. 1891, p. 73.
In the British Museum from "British Guiana."

696. VEHILIUS STICTOMENES.

Staphylus stictomenes, Butler, Trans. Ent. Soc. 1877, p. 153.
New Amsterdam; Demerara; Takutu; Mabaruma.

697. MEGISTIAS TRIPUNCTATUS.

Hesperia tripunctata, Latreille, Enc. Mēth. IX, p. 752, n. 62 (1823).
Demerara; Bartica.

698. MEGISTIAS LEUCONE.

M. leucone, Godman & Salvin, Biol. Cent. Am. Rhop. II., p. 575, t, 101. f. 19-21 (1900).
Omai; Takutu.

699. PARPHORUS STORAX.

Phlebodes storax, Mabille, Compt. Rend. Soc. Ent. Belg. 1891, p. 83.
Mt. Roraima.

700. VORATES DECORA.

Cobalus decora, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 81.
Takutu; Mabaruma.

701. MOLO MANGO.

Hesperia mango, Guénée, Vinson's Voy. Mad. Lep. p. 40 (1865).
In the British Museum from Demerara. This species is better known under the name of *M. heraea* Hew., owing to the fact that the locality of Guénée's *Hesperia mango* was erroneously given as Madagascar!

702. PARACARYSTUS HYPARGYRA.

Cobalus hypargyra, Herrich-Schaeffer, Prodr. Syst. Lep. p. 81, (1869).
Georgetown; Demerara River.

703. PARACARYSTUS MENETRIESII.

Hesperia menetries, Latreille, Enc. Mēth. IX, p. 760, n. 91 (1823).
Demerara; Carimang River.

704. CARYSTUS PHOREUS.

Papilio phoreus, Cramer, Pap. Ex. II, t. 156, D (1779).
Several specimens from "British Guiana" in the British Museum.

705. CARYSTUS ARTONA.

Hesperia artona, Hewitson, Descr. Hesp. p. 27 (1868).
Widely distributed and very common.

706. CARYSTUS JOLUS.

Papilio jolus, Cramer, Pap. Ex. IV, t. 292, I, K (1782).
Parika (A. Hall).

707. ZENIS MINOS.
Hesperia minos, Latreille, Enc. Mēth. IX, p. 756, n. 76 (1823).
Takutu.

708. ZENIS CALVINA.
Hesperia calvina, Hewitson, Trans. Ent. Soc. 1866, p. 492.
Quonga; Kaieteur Falls.

709. VETTIUS PHYLLUS.
Papilio phyllus, Cramer, Pap. Ex. II, t. 176, B, C (1779).
Demerara; Potaro River; Mabaruma.

710. VETTIUS LAUREA.
Hesperia laurea, Hewitson, Descr. Hesp. p. 28, n. 13.
Kaieteur Falls. This species seems doubtfully distinct from *V. phyllus* but Seitz's figure, with which my Kaieteur specimens agree, is rather different to that of Hewitson and may represent something else.

711. VETTIUS LAFRESNAYI.
Hesperia lafrenaye, Latreille, Enc. Mēth. IX, p. 753 (1923).
Bartica; Carimang River; Kaieteur Falls.

712. COELIADES DUBIUS.
Papilio dubius, Cramer, Pap. Ex. IV, t. 354, B, C (1782).
Demerara; Berbice.

713. DION PRINOSA.
D. prinosa, Plotz, Exot. Schmett. 20, Hesp. t. 293.
Takutu.

714. FLACILLA AECAS.
Papilio aecas, Cramer, Pap. Ex. IV, t. 243, A, B (1782).
Bartica; Carimang River; Takutu; Mt. Roraima.

715. CYMAENES PERICLES.
Pamphila pericles, Moschler, Verh. Zool. Bot. Ges. Wien, 1878, p. 218.
Quonga.

716. CYMAENES TELATA.
Cobalus telata, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 81, n. 43 (1869).
Quonga.

717. METHIONOPSIS INA.
M. ina, Plötz, Exot. Schmett. 20, Hesp. t. 261.
Bartica; Carimang River; Kaieteur Falls.

718. EPEUS VELEDA.

E. veleda, Godman & Salvin, Biol. Cent. Am. Rhop. II., p. 601, t. 103, f. 21-23 (1901).

Kaieteur Falls.

719. EPEUS EDATA.

E. edata, Plötz, Exot. Schmett. 20, Hesp. t. 580.

Quonga.

720. CALLIMORMUS FILATA.

Apaustus filata, Plötz, Stett. Ent. Zeit. 1884, p. 158.

Abundant in nearly all localities. Common in the Botanical Gardens at Georgetown.

721. CALLIMORMUS JUVENTUS.

C. juventus, Scudder, Rep. Peab. Ac. Sci. 1872, p. 74.

Quonga.

722. CALLIMORMUS CORADES.

Ancyloxypha corades, Felder, Verh. Zool. Bot. Ges. Wien, 1862, p. 477.

Bartica.

723. MNESTHEUS LUDENS.

Cobalus ludens, Mabille, Compt. Rend. Soc. Ent. Belg. 1891, p. 83.

Kaieteur Falls.

724. ARTINES ATIZIES.

A. atizies, Godman & Salvin, Biol. Cent. Am. Rhop. II., p. 608, t. 103, f. 49, 50 (1901).

Quonga; Mt. Roraima.

725. CARYSTOIDES SICANIA.

Hesperia sicania, Hewitson, Ann. Mag. Nat. Hist. (4), XVIII, p. 454 (1876).

Quonga.

726. CARYSTOIDES CATHAEA.

Hesperia cathaea, Hewitson, Trans. Ent. Soc. 1866, p. 492.

Demerara River; Berbice; Carimang River.

727. DAMAS CLAVUS.

Hesperia clavus, Erichson, Schomb. Reise III, p. 601 (1848).

Berbice.

728. ORSES CYNISCA.

Hesperia cynisca, Swainson, Zool. Ill. I, t. 40 (1820-1821)

Bartica; Annai; Carimang River.

729. THRACIDES PHIDON.

Papilio phidon, Cramer, Pap. Ex. III, t. 245, F, G (1782).
Demerara; Berbice.

730. THRACIDES SALIUS.

Papilio salius, Cramer, Pap. Ex. I, t. 68, E (1779).
Parika.

731. THRACIDES LONGIROSTRIS.

Papilio longirostris, Sepp, Surin. Vlind. I, t. 27 (1848).
Demerara; Berbice; Ida Sabina; Omai; Takutu; Quonga; Georgetown; Bartica. A rather common species.

732. THRACIDES AROMA.

Hesperia aroma, Hewitson, Descr. Hesp. p. 24 (1867).
In the British Museum from "British Guiana."

733. THRACIDES CHIOMARA.

Hesperia chiomara, Hewitson, Ex. Butt. IV, *Hesperia*, t. 2, f. 19 (1867).
Demerara River; Bartica; Carimang River.

734. THRACIDES FISCHERI.

Hesperia fischeri, Latreille, Enc. Méth. IX, p. 747, n. 50 (1823).
Carimang River; Kaieteur Falls.

735. THRACIDES DECINEA.

Hesperia decinea, Hewitson, Ann. Mag. Nat. Hist. (4), XVIII, p. 452 (1876).
Kaieteur Falls.

736. TALIDES SERGESTUS.

Papilio sergestus, Cramer, Pap. Ex. I, t. 74, C (1779).
Demerara; Quonga; Carimang River.

737. TALIDES ADJUNCTUS.

T. adjunctus, Plötz, Exot. Schmett. 20, Hesp. t. 340.
Bartica.

738. PERICHARES CORIDON.

Papilio coridon, Fabricius, Syst. Ent. p. 533, n. 385 (1775).
Demerara; Bartica; Quonga; Takutu; Mt. Roraima.

739. PYRRHOPYGOPSIS THRASEA.

Hesperia thrasea, Hewitson, Trans. Ent. Soc 1866, p. 485.
A female from "British Guiana" in the British Museum.

740. PYRRHOPYGOPSIS CLEANTHES.

Hesperia cleanthes, Latreille, Enc. Mēth. IX. p. 732, n. 9 (1823).
Demerara.

ADDENDA.

Family SATYRIDAE.

741. EUPTYCHIA MOLLINA.

E. mollina, Hübner, Zutr. Ex. Schmett. f. 105, 106 (1818).
Oronoque-New River confluence (G. A. Hudson).

742. EUPTYCHIA JESIA.

E. Jesia, Butler, Lep. Ex. t. 4, f. 6 (1869).
New River (J. G. Myers); Upper Corentyne (G. A. Hudson).

743. EUPTYCHIA NEBULOSA.

E. nebulosa. Butler, Proc. Zool. Soc. 1866, p. 479, n. 61.
Parika (A. Hall).

744. EUPTYCHIA ANTONOE.

Papilio antonoe, Cramer, Pap. Ex. I, t. 60, E. F. (1779).
Parika (A. Hall).

745. EUPTYCHIA NEWTONI.

E. newtoni, sp. nov.

Description. Male. Differs from *E. libye* L. in the presence of a round whitish postdiscal spot on the fore wings just above vein 3. The female only differs in the slightly lighter and more greyish colour of the under surface.

Types from Parika.

This species has hitherto been taken to be an individual form of *E. libye* but Captain Riley has examined the genitalia and found them to be quite distinct.

E. Newtoni also occurs in Trinidad and is in the British Museum from the Lower Amazon; *E. libye* ranges throughout Tropical America.

746. EUPTYCHIA GERA, HEW.

E. gera, Hewitson, Ann. Mag. Nat. Hist. (2), VI, p. 439 (1850).
Oronoque-New River confluence (G. A. Hudson, Aug. 1937).

747. EUPTYCHIA BRISCIUS.

Satyrus briscius, Godart, Enc. Mēth. IX, p. 490, n. 42 (1823).
Annai; Barima River (C. E. Buckle).

748. EUPTYCHIA AEGROTA.

E. aegrota, Butler, Proc. Zool. Soc. 1866, p. 482, n. 72.
In the British Museum from Bartica.

749. EUPTYCHIA CAERULEA.

E. caerulea, Butler, Lep. Ex. I t. 3, f. 1, 2 (1869).
Annai; Quonga; Bartica; Mt. Roraima.

750. EUPTYCHIA CLORIMENE.

Papilio clorimena, Stoll. Suppl. Cram. t. 13, f. 2, 2b, (1790).
Bartica (Coll. B.M.).

751. EUPTYCHIA FURINA.

E. furina, Hewitson, Ex. Butt. III, *Euptychia* t. 1, f. 4 (1862).
Quonga; Mt. Roraima; Oronoque-New River confluence. The British Guiana specimens are not quite typical and probably represent a new subspecies.

752. EUPTYCHIA ITONIS.

E. itonis, Hewitson, Ex. Butt. III. *Euptychia* t. 1, f. 3 (1862).
Annai; Takutu.

Family BRASSOLIDAE.

753. SELENOPHANES CASSIOPE.

Papilio cassiope, Cramer, Pap. Ex. I, t. 57, A. B. (1779).
Konawaru on the Potaro (Coll. Ent. Div.); Mackenzie (Beccari Exp.).

Family NYMPHALIDAE.

Sub-family HELICONIINAE.

754. HELICONIUS SALVINII.

H. salvinii, Dewitz. Mitt. München. Ent. Ver. I, p. 86.
Tumatumari (G. A. Bodkin); Matope; Cuyuni River (Coll. B. M.).

755. HELICONIUS CLYSONYMUS.

H. clysonymus, Latreille in Humb. Bonpl. Obs. Zool. II, p. 128, t. 42, f. 1, 2, (1811-1819).
Issororo, N.W. District (L. D. Cleare).

Sub-family NYMPHALINAE.

756. EUNICA EUROTA.

Papilio eurota, Cramer, Pap. Ex. I, t. 24, C.D. (1775).
Mazaruni River (C. B. Williams). (Coll. Ent. Div.).

757. EUNICA SYDONIA.

Nymphalis sydonia, Godart, Enc. Méth. IX, p. 416, n. 207 (1923).
Essequibo River (Coll. Ent. Div.).

758. CATONEPHELE ANTINOË.

Nymphalis antinöe, Godart, Enc. Méth. IX, p. 410, n. 197 (1823).
Catonephele beccarii, Verity, Mem. Soc. Ent. Ital. 1934, p. 77.
Marlissa, Berbice River (Beccari Exped.).

Seitz has figured a male of *C. chromis* under the name of *C. antinöe* and this has misled Dr. Verity into re-describing the true *C. antinöe* as *C. beccarii*,

759. CATAGRAMMA EXCELSIOR.

C. excelsior, Hewitson, Ex. Butt. II, *Catagramma* t. 7, f. 49, 50 (1858).

Verity records a female as having been taken on the Demerara River by the Beccari Expedition. If no mistake in identification has been made the record is a remarkable one as this very conspicuous species has not hitherto been known from any locality nearer than the Rio Manes on the South side of the Amazon.

760. ECTIMA LIRIA.

Papilio liria, Fabricius, Ent. Syst. III, (i), p. 239, n. 747, (1793).

Wismar (A. Hall, March 1939).

761. MEGALURA EGINA.

Timetes egina, Bates, Journ. Ent. II, p. 329, t. 10, f. 1 (1865).

"Baboon Camp" (Beccari Expedition).

762. PREPONA LAERTES IKARIOS.

P. laertes ikarios, Fruhstorfer, "Insektenborde", 1904, p. 126.

In the Tring Museum from Demerara.

763. PREPONA DEMODICE.

Nymphalis demodice, Godart, Enc. Méth. IX, p. 408, n. 193 (1823).

Berbice (W. E. Augustus). (Coll. Ent. Div.).

764. AGRIAS NARCISSUS.

A. narcissus, Standinger, Ex. Tagf. I, p. 165, t 57 (1888).

Oronoque-New River confluence (Major Beddington). This is the first record of this splendid species from British Guiana.

Family ERYCINIDAE.

765. THEMONE POECILA.

T. poecila, Bates, Journ. Linn. Soc. Zool. IX, p. 378 (1868).

Oronoque-New River confluence (Major Beddington).

766. TMETOGLENE COLAXES GUIANENSIS.

T. colaxes guianensis subsp. nov.

Description. Fore wings less pointed than in typical *T. Colaxes* Hew. from Ecuador, the subapical band of white spots followed by an additional small spot in cellule 2; marginal black band of hind wings only about half as wide. Oronoque-New River confluence (Major Beddington). Type in the British Museum.

767. SYMMACHIA ACCUSATRIX.

S. accusatrix, Westwood, Gen. Diurn. Lep. p. 445, n. 3, note (1851).

Brazil-British Guiana Boundary (Major Beddington).

768. NYMPHIDIUM MINUTA.
N. minuta, Druce. Proc. Zool. Soc. 1904, p. 487.
Parika (A. Hall).
A very small species but apparently common.

769. ARICORIS EPITUS.
Papilio epitus, Cramer, Pap. Ex. III, t. 270, C. (1782).
Coverden, Demerara River (A. Hall, March, 1939).

770. THEOPE LEUCANTHE.
T. leucanthe, Bates, Journ. Linn. Soc. IX, p. 405 (1868).
Marlissa, Berbice River (Beccari Exped.).

771. THEOPE THOOTES.
T. thootes, Hewitson, Ex. Butt. II, *Theope* t. 1, f. 9, 10 (1860).
Parika.

Family LYCAENIDAE.

772. THECLA GABRIELA.
Papilio gabriela, Cramer, Pap. Ex. I, t. 6, C.D. (1775).
Berbice (W. E. Augustus). (Coll. Ent. Div.).

773. THECLA PHILINNA.
T. philinna, Hewitson, Descr. Lyc. p. 19, n. 43 (1868).
Parika.

774. THECLA CYDIA.
T. cydia, Hewitson, Ill. Diurn. Lep. p. 160, n. 285, t. 63, f. 433, 434 (1874).
Paradise, Berbice River (Beccari Exped.).

775. THECLA VESULUS.
Papilio vesulus, Cramer, Pap. Ex. IV, p. 340, I.K. (1782).
Wismar (A. Hall).

776. THECLA MEGACLES.
Papilio megacles, Cramer, Pap. Ex. IV, t. 333, E.F. (1782).
Rockstone (Beccari Exped.).

776a. THECLA CALUS.
Polyommatus calus, Godart, Enc. Méth. IX, p. 640, n. 83 (1823).
Parika (A. Hall, March 1939).

777. THECLA POLIBETES.
Papilio polibetes, Cramer, Pap. Ex. IV, t. 341, B.C. (1782).
Parika.

778. THECLA ARUMA.

T. aruma, Hewitson, Ill. Diurn. Lep. p. 192, n. 375, t. 76, f. 609, 610 (1877).

Carimang River; Mt. Roraima.

779. THECLA ANTHORA.

T. anthora, Hewitson, Ill. Diurn. Lep. p. 191, n. 373, t. 76, f. 604, 605, 606 (1877).

Kurupukari, Demerara River (Beccari Exped.).

Family HESPERIDAE

Sub-family PYRRHOPIGINAE

780. PYRRHOPYGE PROCULUS.

P. proculus, Hopffer, Stett. Ent. Zeit. 1874, p 370, n. 3.

Coverden, Demerara River (A. Hall); New River (G. A. Hudson).

781. PYRRHOPYGE RILEYI GUIANAE.

P. rileyi guianae, Bell, Ent. News XLII, p 68 (1932).

Parika (A. Hall).

782. JEMADIA FALLAX.

J. fallax, Mabille, Ann. Ent. Soc. Belg. XXI, p. 22.

New River (G. A. Hudson).

Sub-family HESPERIINAE.

783. PHOCIDES DISTANS.

Erycides distans, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 60, n. 4 (1869).

Great Falls (Beccari Exped.).

784. HETEROPIA IMALENA.

Telegonus imalena, Butler, Lep. Ex. p. 109, t. 40, f. 1 (1872)

Demerara River (Beccari Exped.).

785. CHRYSOPLECTRUM PERRICIOSUM.

Eudamus perriciosus, Herrich-Schaeffer, Prodr. Syst. Lep III, p. 65. n. 13 (1869).

Coverden, Demerara River (A. Hall).

Always a rare species.

786. BUNGALOTIS RAMUSIS.

Papilio ramusis, Cramer, Pap. Ex. IV, t. 342, C (1782).

Hosororo, N.W. District (L. D. Cleare); New River (G. A. Hudson).

787. NASCUS EURIBATES.

Papilio euribates, Cramer, Pap. Ex. IV, t. 393, D (1782).
Oronoque-New River confluence (Major Beddington).

788. PARADROS ALCMON.

Papilio alcmon, Cramer, Pap. Ex. III, t. 261, D.E. (1782).
Marlissa, Berbice River (Beccari Exped.).

789. PARADROS DUMERILI.

Hesperia dumeril, Latreille, Enc. Méth. IX, p. 757, n. Bo (1823).
Oronoque River (Major Beddington).

790. GARGA PLATON.

Conognathus platon, Felder, Wien. Ent. Mon. VI, p. 181, n. 163 (1862).
New River (G. A. Hudson).

791. PYTHONIDES LERNIA.

Leucochitonea lernia, Hewitson, Descr. Hesp. p. 48, n. 6 (1868).
New River (G. A. Hudson).

792. PYTHONIDES LUGUBRIS.

Leucochitonea lugubris, Felder, Verh. Zool. Bot. Ges. 1869, p. 476, n. 32.
Parika; Kaieteur Falls.

793. PELLICIA BESSUS.

P. bessus, Moschler, Verh. Zool. Bot. Ges. Wien XXV, p. 341, t. 4, f. 25 (1876).
Parika; Mabaruma.

794. EUDAMIDAS OZEMA.

Achlyodes ozema, Butler, Trans. Ent. Soc. 1870, p. 515.
Kurupukari, Demerara River (Beccari Exped.).

795. EBRIETAS UNDULATUS.

Nisoniades undulatus, Herrich-Schaeffer, Corresp. Blatt. Regensb. XVIII, p. 171 (1864).
Demerara River, Parika.

796. MILTOMIGES VERTICALIS.

M. verticalis, Plötz. Exot. Schmett. Hesp. XX, p. 1478.
Coverden, Demerara River (A. Hall).
This rare species probably belongs to some other genus.

Sub-family PAMPHILINAE.

797. COPAEOIDES MINIMA.

C. minima, Edwards, Trans. Am. Ent. Soc. III, p. 196 (1870).
Kaieteur Savannah (Smart & Richards).

798. PRENES CORNELIUS.

Hesperia cornelius, Latreille, Enc. Méth. IX, p. 764, n. 104 (1823).

Parika; Coverden.

799. CYDRUS NAEVOLUS.

C. naevolus, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 513, t. 96, f. 19-21, (1900).

Parika (A. Hall).

800. EUROTO COMPTA.

Pamphila compta, Butler, Trans. Ent. Soc. 1877, p. 152.

Parika; Coverden.

801. EUROTO GEISA.

Pamphila geisa, Moschler, Verh. Zool. Bot. Ges Wien. 1878, p. 216.

Parika; Coverden.

This species appears to be quite distinct from *E. compta*, not synonym as given in Seitz.

802. LEREMA PENEIA.

L. peneia, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 555, t. 99, f 48, 49 (1900).

Parika.

803. MNASILUS PENCILLATUS.

M. pencillatus, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 570, t. 100, f. 39-42 (1900).

Bartica.

804. VEHILIUS SCHERIA.

H. scheria, Plotz. Exot. Schmett. XX, Hesp. t. 1475.

Coverden, Demerara River.

805. MEGISTIAS TRIPUNCTUS.

Cobalus tripunctus, Herrich-Schaeffer, Corresp. Blatt. Regensb. XIX, p. 53 (1865).

Mt. Roraima; Coverden.

806. MEGISTIAS ISUS.

M. isus, Godman & Salvin, Biol. Cent. Am. Rhop. II, p. 574, t. 101, f. 9-11 (1900).

Quonga.

807. ZENIS DISSOLUTA.

Cobalus dissoluta, Herrich-Schaeffer, Prodr. Syst. Lep. III, p. 78, n. 7 (1869).

Parika.

808. CYMAENES SILIUS.

Hesperia silius, Latreille, Enc. Méth. IX, p. 764, n. 103 (1823).
Quonga; Parika.

809. MNASEAS BICOLOR.

M. bicolor, Mabille, La Naturaliste, 1889, p. 174.
Parika; Mabaruma.

810. CALLIMORMUS VETULA.

C. vetula, Mabille, La Naturaliste, 1888, p. 173.
Bartica; Coverden; Kaieteur Falls.

811. CALLIMORMUS DIAESES.

C. diaeses, Schaus. Proc. U.S. Nat. Mus. 1902, p. 456.
Coverden; Parika; Quonga.

812. THEMESION MAROMA.

Carystus maroma, Möschler, Verh. Zool. Bot. Ges. Wien, XXVI, p. 330 (1876).
Mackenzie (Beccari Exped.).

813. THRACIDES ANTONINUS.

Hesperia antoninus, Latreille, Enc. Méth. IX, p. 746, n. 47 (1823).
Parika; Coverden.

This species appears from the genitalia to be distinct from *T. salius*, Cram. to which, however, it is very similar.

CORRECTIONS.

Page 33. n. 63. In place of *Euptychia batesii* read *E. harpyia*, Felder, Reise Nov. Lep. III p. 482, n. 832 (1867).

Page 37. for *Heliconiinea* read *Heliconiinae.*

Page 97. n. 155 for *Eunica moninia* read *E. monima.*

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O

NOTE.

MINUTES OF THE SEVENTEENTH MEETING OF THE ADVISORY BOARD OF AGRICULTURE

HELD AT THE OFFICE OF THE DEPARTMENT OF AGRICULTURE ON WEDNESDAY, AUGUST 16, 1939, AT 1.30 O'CLOCK P.M.

PRESENT.

The Director of Agriculture	... .	*Chairman*
The Deputy Director of Agriculture (ag.)	... .	
Hon. R. E. Brassington		
" J. W. Jackson	....	*Members*
" E. M. Walcott		
Mr. S. Andries		

with

Capt. J. F. Irving, M.C.	... .	*Secretary*

ABSENT.

Hon. Peer Bacchus

Mr. W. H. Richards.

An excuse for non-attendance was tendered by Mr. W. H. Richards who had to be present elsewhere at another Government meeting at the same hour. The Chairman observed that it was becoming increasingly difficult to find convenient days for most meetings.

Minutes. The minutes of the last meeting held on January 25 which had previously been circulated were confirmed. The Chairman referred to the following matters relating thereto :

(1) *Berbice Exhibition.* The Chairman stated that the Agricultural Exhibition staged at New Amsterdam could be considered highly satisfactory having regard to the adverse weather conditions. It was estimated that 5,000 persons were present. The total receipts, comprising an allocation of \$500 from the Department's grant-in-aid vote, gate receipts, contributions from the Sugar Producers' Association, the Rice Marketing Board and the Berbice Agricultural Committee, amounted to \$937.58 as against an expenditure of \$1,274.34, leaving a deficit of \$336.76 which would be met by a further allocation from the grant-in-aid vote, field competitions having been cancelled to permit of this. The expenditure was higher than was anticipated due to the heavy rains and the consequent additional expense involved in keeping the grounds free of water, purchase of shell for the paths, and the necessity for the hire of galvanised sheets and duck-boards for the stands.

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" J. W. Jackson	....	*Members*
" E. M. Walcott		
Mr. S. Andries		

with

Capt. J. F. Irving, M.C.	....	*Secretary*

ABSENT.

Hon. Peer Bacchus

Mr. W. H. Richards.

An excuse for non-attendance was tendered by Mr. W. H. Richards who had to be present elsewhere at another Government meeting at the same hour. The Chairman observed that it was becoming increasingly difficult to find convenient days for most meetings.

Minutes. The minutes of the last meeting held on January 25 which had previously been circulated were confirmed. The Chairman referred to the following matters relating thereto :

(1) *Berbice Exhibition.* The Chairman stated that the Agricultural Exhibition staged at New Amsterdam could be considered highly satisfactory having regard to the adverse weather conditions. It was estimated that 5,000 persons were present. The total receipts, comprising an allocation of $500 from the Department's grant-in-aid vote, gate receipts, contributions from the Sugar Producers' Association, the Rice Marketing Board and the Berbice Agricultural Committee, amounted to $937.58 as against an expenditure of $1,274.34, leaving a deficit of $336.76 which would be met by a further allocation from the grant-in-aid vote, field competitions having been cancelled to permit of this. The expenditure was higher than was anticipated due to the heavy rains and the consequent additional expense involved in keeping the grounds free of water, purchase of shell for the paths, and the necessity for the hire of galvanised sheets and duck-boards for the stands.

(2) *Banana Experiments.* As previously recommended by the Board, the 5-acre banana block at Plantation Middlesex had been abandoned and cassava trials had been laid down there instead. At Supply the bananas, despite regular attention to cultivation, etc., were growing very poorly. Cercospora leaf spot was still present, though it had not been so bad this year owing to drier weather. Panama disease was increasing. As a commercial proposition this plot must also be regarded as a failure.

(3) *Rice Mill Engineer.* The Chairman stated that as members were no doubt aware, the Report on Rice Milling in British Guiana by Mr. H. Parker and the Essequibo Coast Rice Committee Report had been [illegible]ed. The whole question of a Central Rice Mill had now been thoroug[illegible] i[illegible]ti-gated, and estimates in connection therewith forwarded to the [illegible] of State.

(4) *Tobacco Industry.* The Chairman reported the accepta[illegible] Legislative Council, from the Colonial Development Fund, of a [illegible] of £3,690 to cover the salary and expenses of a tobacco expert [illegible] Bradshaw, a tobacco planter of Nyasaland, had been selected, and [illegible] in this Colony about October.

Rice Industry. Attention of members was called to an interesting [illegible] by the Assistant Plant Breeder on Rice Variety Trials which appear[illegible] the March number of the *Agricultural Journal of British Guiana.* A[illegible] sideration of the present results and those obtained in previous years [illegible] led to the following general conclusions :

1. Judged from the yield standpoint only, D 114 is the best of all th[illegible] varieties available.
2. No well tested long-grained variety as yet offers as a substitute for Demerara Creole, which had been brought to a high state of purity by selection.
3. D 99, D 109 and D 110 are heavier yielders than the standard medium-grained varieties No. 79 and Blue Stick, and are worthy of commercial consideration.

In addition to existing breeding work the Department was still introducing for trial here a large number of new varieties from India.

Mr. Walcott stated that the whole question of the Rice Industry was causing a great deal of anxiety to those concerned as there had been a distinct tendency to decrease production. This was, he thought, the result of bad advice given to growers and others by so-called leaders of the people. It was hoped, however, that a vigorous propaganda which the Rice Marketing Board proposed to inaugurate shortly would have a good effect and help to stem this retrograde step, which he regarded with grave concern.

The Chairman said the Department of Agriculture was doing everything possible to encourage growers but there was no denying that the industry was suffering from internal dissension, which, coupled with a lower price level, reacted unfavourably on the grower.

Livestock Industry. The Chairman announced the appointment of Mr. H. A. Fraser as Government Veterinary Surgeon in the place of Major T. Bone who had recently retired. It was proposed that Mr. Fraser, who had had considerable experience in animal husbandry, should give this phase of livestock work his full attention, and that practical talks on the subject would b[illegible]ted first at the Stock Farm, Georgetown, and then extended to v[illegible]s' of the Colony.

[illegible]airman mentioned that another order had been placed in England [illegible] Poll bull and a Holstein-Friesian bull. The bulls at La Belle [illegible]d been well employed, and he was glad to say that a greater [illegible] being shown in livestock matters generally all over the Colony.

[illegible]xport of livestock to Trinidad was referred to and the number [illegible]ls and eggs being exported noted with interest. A diagram demon- [illegible] the growth of the trade, which had been prepared by the Economist [illegible] Berbice Exhibition, was displayed.

[illegible]r. Brassington said he understood that there had been a large increase [illegible]e number of pigs slaughtered by the local butcheries. It was pointed [illegible]hat pig-rearing was proving profitable in connection with the coconut oil [illegible]stry and that there was a good demand for breeding animals from the [illegible]k Farm.

In regard to poultry, there had been a very large demand for eggs and birds from the Livestock Division, and in consequence two further pens of Barred Rocks had been ordered from Canada.

Papaw. The Chairman said that he had forwarded to the Imperial Institute, London, samples of certain papaw products prepared by a local manufacturer seeking markets for these articles, and he had been informed by the Institute that it had not been possible to find buyers, as it appeared that there was no market for such products in the United Kingdom. He was also informed that there was a large number of proprietary jams, preserves and other such products on the market at the present time and it was difficult to interest the public in new lines when so many well established products were available. If there was any market for such products it was suggested that it would be more profitable to ship in bulk for bottling on the other side and thus save freight on bottles.

Split Peas. The Chairman mentioned that in connection with efforts to increase certain food supplies now imported, the Department had been working on the production of dhal or split peas. He exhibited a sample of such peas made from Pigeon Peas by the Chemist, which was considered

highly satisfactory. The processing was easy now that a method had been found, but there was still some little difficulty in finding a suitable home-made apparatus for splitting, the idea being that farmers would grow and make their own split peas in the first instance instead of buying.

Annual Estimates. The pulls in connection with the 1940 estimates were not yet available, but the Chairman said there was no great difference from the 1939 figure; it was proposed, however, to expend more money on livestock, and this was being largely met by re-adjustment of the existing sub-heads.

Minor Products Markets. The Chairman reported that the [illegible] of marketing certain local products had been taken up with the Colon[illegible] Marketing Board but the report received was not at all promising. [illegible] following is a summary of the information received.

Liberian Coffee. There was no market for coffee from this Colony in the United Kingdom. The export trade opinion was that it was of a poor quality, coarse and bitter in the liquor, and quite unsuitable for the home trade. It was thought that the Scandinavian and Baltic countries would offer more favourable outlets for this class of coffee.

Plantain Flour. It was stated that one of the principal firms of brokers had still on their hands the last consignment of this flour forwarded them from British Guiana.

Cassava. Java holds a dominating position for cassava products Malaya is also concerned with this industry but is altogether unable to compete with the Javan products of either cassava or tapioca in the English market, and the Marketing Board feels that there is nothing to encourage the hope that British Guiana will be able to compete in this market.

Fruit Juices. The question of Fruit Juices was in hand and a report on the subject of the marketing of East African Passion Fruit Juice had a bearing on the question of fruit juice production, preservation and marketing. The whole subject is of such importance to the citrus fruit growers of the Colonial Empire that the Board proposes to continue its enquiries and to issue a further report on the various processes of juice concentration.

The meeting then adjourned *sine die.*

PLANT AND SEED EXCHANGE.

For the period ending November 1939.

INTRODUCTIONS.

NAME	QUANTITY.	WHENCE SUPPLIED
Economic.		
Padi—6 varieties	packet each	Division of Plant Exploration and Introduction, Bureau of Plant Industry, U.S. Dept. of Agriculture, Washington, D.C., U.S.A,
	8 oz. each	Paddy Specialist, Madras Agricultural Department, Coimbatore, India.
„ 9 varieties	3 lb.	Rice Specialist, Bihar, Sabour, India
2 varieties	½ lb. each	Director of Agriculture, Trichur, India,
Tobacco—3 varieties	1 oz. each	Superintendent, Botanical Substation, Pusa, Bihar, India
Soya Beans—6 varieties	100 gms. each	Bureau of Plant Industry, Dept. of Agr. & Commerce, Manila, Philippine Is.
Vegetable Seeds Assorted	22 lb. 3½ oz.	Messrs. Peter Henderson & Co.. U.S.A
„ „ „	46 lbs. 6 oz	Messrs Hastings & Co., Atlanta, U S.A.
Spinach—New Zealand	½ lb	Messrs. Atlee, Burpee & Co., Pa, U.S.A.
Lettuce—Big Boston	4 oz.	do.
„ —Green Mignonette	1 packet	Ferry-Morse Seed Co., California, U S.A.
Onion Seed—Red and White	14 lb. each	Messrs. Hamilton & Co., Teneriffe.
Sweet Corn 4 varieties	¼ lb. each	do.
Carica Papaya—var solo	1 oz. seeds	Canal Zone Expt. Gardens, Summit, Canal Zone.
Ornamental.		
Raphia ? vinifera	1 lb.	Agricultural Officer, Njala, Mano, Sierra Leone.
Raphia gracilis	1 lb.	do.
Anisophyllea laurina	1 lb.	do.
Petunia Seeds	11 packets	Messrs. Richard Diener, Oxnard, California, U.S.A
Dahlia Seeds	2 packets	do
Daisy Seeds	1 packet	do.
Hibiscus—Yellow	1 plant	Private Collector.
Oleander Yellow	1 plant	do.

INTRODUCTIONS.

Name	Quantity	Whence Supplied
Sunflower Seeds	6 oz.	Messrs. Peter Henderson & Co., U.S.A.
Sweet Peas—18 varieties	1 packet each	Messrs. W. Atlee, Burpee & Co., Pa.. U.S.A.
,, ,, 7 ,,	1 packet each	
Ipomea—Heavenly Blue	1 packet	
,, —Scarlet O'Hara	1 packet each	
Neanthe bella	2 oz.	
Ornamental Seeds	1 packet	
,, Cuttings	23	
,, Plants	10	
Bougainvillea—Varieties—Nos. 2 and 14	cuttings	
Acacia macrantha	1 oz. seeds	

DESPATCHES.

Name	Quantity	Destination.
Economic.		
Beans—3 varieties	1 packet each	Messrs. Sutton & Sons, 13 D, Russell Street, Calcutta, India.
Ipomoea tiliacea	1 lb. tubers	Harvard University, Atkins Institution of the Arnold, Arboretum, Cuba.
Soya Beans White Caracas	1 lb	Bureau of Plant Industry, Dept. of Agr. & Commerce, Manila, Philippine Is
Caryocar nucifera	1 plant	Director of Agriculture, Trinidad.
Hevea brasiliensis	3 lb. seed	Biological Laboratories, Harvard University, Mass., U.S.A.
Passiflora coccinea	1 packet	East African Agrl. Research Station, Amani, Tanganyika, British East Africa.
,, *laurifolia*	1 packet	do.
,, *nitida*	1 packet	do.
,, *quadrangularis*	1 packet	do.
Pineapple—Smooth Cayenne	8 suckers	Agricultural Superintendent, St. Lucia.
—Sugar Loaf	10 suckers	do.

PLANT AND SEED EXCHANGE—(*Contd.*)

DESPATCHES.

NAME	QUANTITY	DESTINATION
Ornamental.		
Aegiphila martinicensis	1 packet seed	Agricultural Superintendent, St. Lucia.
	1 packet seed	do.
	2½ lb. seed	Botanist, Dept. of Agriculture, Ceylon.
	20 lb. seed	Dr. G. Stahel, Director of Agriculture, Parimaribo, Surinam.
	12 seeds	Director of Agriculture, Barbados.
	12 seeds	Director of Agriculture, Trinidad.
	6 cuttings do. do	Horticulturist, U.S. Dept. of Agriculture, Agrl. Expt. Station, Mayaguez, Puerto Rico.
	3 doz seeds	do.
	16 packets	Dept. of Agriculture, Njala, Mano, Sierra Leone, British West Africa.
"	18 packets	Dept. of Parks, Division of Forestry, Los Angeles California, U.S.A.
" "	7 packets	The Horticulturist, Dept. of Agriculture, Bermuda.
" "	4 packets	The Curator, Dept. of Botany, The University, Stellenbosch, S. Africa
" "	7 packets	The Middle Egypt Botanic Station, El Saff, Egypt.
" "	16 packets	Private Collectors.
" Plants	6 plants	do.

METEOROLOGICAL DATA—JULY—SEPTEMBER, 1939.

Recording Stations & Months.	Rain-fall. Total Inches.	Number of Days of Rain: Under .10 Inch	.10 to .50 Inch	.50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days	Evaporation Inches	Air Temperature and Humidity. Maximum.	Minimum.	Mean.	Humidity Mean
Botanic Gardens.												
July ...	10.18	4	15	3	3	...	25	4.37	85.1	75.6	80.3	86.1
August ...	3.08	6	6	1	1	...	14	5.78	86.8	76.8	[illegible]	78.7
September ...	2.43	1	2	1	1	...	5	6.37	87.5	76.7	82.1	78.6
Totals	15.69	11	23	5	5	...	44	16.52	...	[illegible]	[illegible]	[illegible]
Means	...	...	...	...	...	...	...	...	86.5	[illegible]	[illegible]	[illegible]
Berbice Gardens.												
July ...	16.88	9	11	3	2	3	28	...	86.7	[illegible]	[illegible]	81.9
August ...	2.91	10	6	1	...	...	17	...	88.5	75.7	[illegible]	78.5
September* ...	.70	3	2	...	...	...	5	...	89.1	75.4	[illegible]	77.9
Totals	20.49	22	19	4	2	3	50	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	88.1	75.4	81.7	[illegible]
Onderneeming.												
July ...	8.59	1	12	4	2	...	19	...	...	...	...	...
August ...	5.06	1	4	1	2	...	8	...	...	...	...	...
September ...	3.91	...	2	2	...	1	5	...	...	...	...	...
Totals	17.56	2	18	7	4	1	32	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	...	...	...	...
Hosororo, North West District												
July ...	13.00	5	18	2	3	1	30	...	85.5	70.7	78.1	88.9
August ...	8.94	7	10	4	3	...	24	...	88.0	70.8	79.4	86.9
September ...	6.66	3	8	5	1	...	17	...	88.5	70.9	79.7	83.9
Totals	28.60	15	36	12	7	1	71	...	...	...	...	...
Means	...	...	...	...	...	...	...	...	87.3	70.8	79.1	86.6

* Records inaccurate.

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